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IN EXCHANGE.

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ON THE
SURGICAL DISEASES AND INJURIES
OF THE
NOSE, LARYNX, THORAX WITH ITS CONTENTS,
AND OF THE
ORGANS OF CIRCULATION.

BY THOMAS BRYANT.

CHAPTER I.

SURGICAL DISEASES OF THE NOSE.

CONSIDERING for one moment the extent of the respiratory tract, and the various important parts and organs which combine to form it as a whole; remembering, at the same time, the special functions of the nose and larynx; it can be no subject of surprise that the diseases of the respiratory passages should possess a double interest, both as being the seat of special functions, as well as forming the machinery of the important office of respiration. In the following pages I propose to consider the nose, larynx, and thorax with its contents, especially in their relation to clinical surgery, and it will be my endeavour to illustrate their various morbid conditions, with their appropriate treatment, as they come under the notice of the surgeon.

Commencing with the nasal cavity, the *obstructive diseases* are the most frequent, and it is on their account that the patient

generally applies to the surgeon; in the infant such a condition may be the result of congenital syphilis, which will be indicated by the history and by the concomitant symptoms. The "snuffles" in infancy is very characteristic, and should always direct the practitioner to look out for some specific affection; in isolated cases it may be the only symptom of hereditary syphilis, and by proper treatment it may be cured without any other complication making its appearance; although, as a rule, if looked for, some cutaneous affection will be observed. The mercurial treatment is strongly to be recommended, a grain of gray powder, with three or four of dried soda, twice a day, generally proving quite sufficient to cure the disease.

Foreign body in the nasal cavity.—In older children, suffering from any obstruction to the nasal cavity, the presence of a foreign body should always be suspected; the absence of a history in such instances should never be allowed to mislead the practitioner, as instances are not uncommon where some foreign body has been left in the nasal canal for many months. A child, four years of age, not long since, came under my care, who had suffered from all the miseries of an obstructed nasal passage for eight months, from the presence of a plum-stone. Many remedies had been tried, but without effect, the foreign body being unsuspected; its removal was rapidly followed by convalescence. Ulcerations of the mucous membrane, from the inflammation excited by the foreign body, may tempt the surgeon to overlook the nature of the case; he must therefore remember that such a disease as ulceration of the nose in children, except at the immediate orifice, is by no means common, and that the probabilities of its being excited by a foreign body are very great.

The removal of these bodies, when firmly impacted, requires some care, and the administration of chloroform cannot be too highly recommended, particularly when the child is young and is likely to offer much resistance, which may generally be expected. A firm, hook-bent probe, introduced down the floor of the nose, may be passed with facility behind the foreign body, which may then be extracted with some slight force; in some cases a pair of forceps will suffice; gingerbread and other soft materials should be scooped out, and the nose well syringed. I have never known any good result from syringing this cavity.

when any solid body has become impacted, and do not therefore advise such a practice, except for cleanliness and to obtain a good view. Mechanical means always succeed, and are the simplest, particularly when the child is under the influence of chloroform.

In older children and in adult life obstruction to the nasal passage may be produced by many diseases. The presence of a foreign body may be the cause, in which case a true history will generally be given, and thus the surgeon is more likely to arrive at a just conclusion as to the character of the disease.

Polypus nasi is by far the most common. It may be found in one or both nostrils, in the old or young; it may be of a simple gelatinous, fibro-cellular, or fibrous structure, or of a malignant nature. The gelatiniform and the fibro-cellular are by far the most common, and are not difficult to recognise; they, as a rule, spring from the middle turbinated bone and from its posterior portion; they may, however, grow from other parts, but never from the septum.

They are seldom recognised in an early condition, as they cause no pain and but little inconvenience to the patient; a slight excess of discharge is the earliest symptom, and this is generally regarded as being the result of "cold;" but when this secretion is examined, it will be observed to be more serous than is found to exist in an ordinary coryza. The discharge continuing, may at last cause some anxiety to the patient, and if the surgeon be consulted, a careful examination with a speculum should be instituted, when a polypus, or rather a fringe of polypi, will often be observed on the margin of the middle turbinated bone. When the disease has been made out, removal of the growth is the only effectual treatment. Tonics and local astringents may for a time retard their growth, but can never be expected to effect a cure; the application of the powdered sulphate of zinc as a snuff has been much advised, but I cannot quote an example in which I have observed any decided benefit from its use; it gives much pain at times to the patient and causes even ulceration of the mucous membrane, and I am disposed to regard the inconvenience produced by its use as far outweighing its beneficial influence. The use of an astringent, such as tannin, as a lotion, appears to me to be much more efficacious, and it

may be employed of variable strength without causing any inconvenience, about five to ten grains to the ounce being the most useful.

The removal of these softer kinds of polypi should always be by abruption. Some surgeons employ a long pair of well-made forceps, which merely fix the pedicle, and then, by a slight twist and some force, removal is effected. But the best instrument by far is a "noose," as invented, I believe, by Mr. Hilton; it is an instrument which can be easily handled, and is so constructed as to pass a wire over the polypus, and having encircled its base, strangulation and abruption is easily accomplished; its advantage is shown in the facility with which it can be manipulated, and the almost certainty with which the pedicle alone is encircled; ensuring the removal of the growth, without its laceration; and preventing the evils which follow from the flow of blood when caused by a laceration of the polypus itself. By the use of this instrument the nose may generally be completely cleared at one operation; and this great advantage cannot be realised when the forceps alone are employed; for by these the polypus itself is commonly injured, and any further proceedings are interfered with by the hæmorrhage which is sure to follow. Subsequent to the operation the use of an astringent lotion may be strongly recommended, the tannin being my favorite one, about five grains to the ounce.

Examples of nasal polypi of the simpler kind are not often admitted into the hospital. I have notes of but twenty-two cases during the last six years; sixteen being males, and six females. Ten commenced in patients under twenty years of age; five between twenty and thirty; four between thirty and forty; three between forty and sixty; the youngest being eight and the oldest seventy-five years of age, but in the latter the disease had existed for many years.

It would thus appear that in early and adult life it is the most frequent, and that as age progresses the tendency to the development of such growths considerably diminishes.

The *firmer and fibrous forms of polypi* seldom spring from the turbinated bones; the gelatinous and fibro-cellular almost alone monopolising this position. The former are by no means so common, and appear to grow more frequently from the upper and posterior portion of the nasal cavity; they do not make

their appearance so early in life, are far more serious in their nature, and are more difficult, on account of their position, to treat.

Their removal is the only efficient treatment, and this can only be done when the tumour is favorably situated. If it grows forward, the nose may be slit up and the growth removed, either by excision, ligature, or both.

If they press backwards down the pharynx, means adapted to the requirements of the case, calculated to procure a like end, must be employed: the soft palate may require division, but such a practice should not be performed unless absolutely essential. In the following case the difficulties and dangers of the disease are well exemplified, and also the benefit of a sound practice.

CASE.—A boy, æt. 15, was admitted into Guy's Hospital under the care of Mr. Cock. For two years he had been the subject of a gradually enlarging polypus of the left nostril, and one year previously had undergone an operation in a metropolitan hospital for its removal; it returned, however, immediately, and grew rapidly, projecting for some extent from the nostril. Some hæmorrhage occasionally took place from it, rendering the boy pale and bloodless.

When admitted, there was a large, malignant-looking tumour, dilating and projecting from the left nostril; it passed backwards also into the pharynx, and pushed forwards the soft palate. The boy was much exhausted from the discharge and from repeated hæmorrhage; none other but local symptoms were present.

A few days after admission severe bleeding took place, inducing Mr. Cock to apply at once, by means of a double canula, a strong ligature around its base; having previously slit up the nostril to give room for manipulation; on the seventh day the strangulated mass came away, and the parts slowly healed. The chloride of zinc paste was subsequently applied to the pharyngeal root of the growth with perfect success, no return having taken place four years subsequently.

About one year after the operation the edges of the nostril

were pared, and brought together ; good union resulted, and thus a perfect recovery ensued.

In *malignant polypi* like treatment is required, although equal success cannot necessarily be expected. The difficulty of the prognosis in these cases results always from the difficulty of forming a correct diagnosis, for when these larger growths have ulcerated, the character and fœtor of the discharges are always liable to mislead, and thus a simple growth may be mistaken for a malignant one, and *vice versâ*.

The treatment, however, in both is somewhat similar. Where excision can be performed, it should be carried out, for by such means great temporary relief is offered to the patient. If otherwise, palliative measures alone can be employed ; the discharges should be frequently washed away by means of the syringe, and some slight astringent lotion, such as the lead, alum, or tannin, topically applied to arrest secretion, prevent hæmorrhage, and in a measure retard the growth of the disease.

I have five examples of suspected or proved malignant polypus of the nose. Two passed forwards, and relief was obtained by the excision of the growth. Three passed backwards into the pharynx, in which palliative treatment alone was employed.

There are other conditions of the nasal cavity which are not unfrequently mistaken for polypus ; many such have passed under my notice, the patients applying for the removal of the growth when, in reality, none such existed.

The first condition which I shall bring forward is a *malformation of the septum nasi*, the septum projecting either into the right or left nostril, and thus causing more or less obstruction to respiration, leading a superficial observer to believe in the presence of some new growth. The knowledge of the existence of such a condition is quite sufficient to prevent any careful surgeon falling into such an error. One case of a girl, æt. 11, was admitted into Guy's Hospital with such a condition, having been sent far out of the country to have the so-called polypus removed.

The second condition of the nose which may be, and frequently is, mistaken for polypus, is a *chronic inflammation and consequent thickening of its mucous lining*.

The patient complains of difficulty in respiration, and feels that there is something in the nose which mechanically impedes that function. On examining the cavity, a smooth, projecting, and firm outgrowth will be observed on its outer wall, which may be regarded as a polypus, but which is really only the lower turbinated bone covered by a thickened and inflamed mucous membrane.

If a little care be taken in the history of the case, an obstruction to the respiration is the only symptom of any importance; there is no serous discharge, which is to be found so copious in cases of polypi, although there may be a discharge of tenacious mucus; but this is not common. The secreting function of the mucous membrane in these cases is generally diminished, and a great dryness may be present, accompanied with a loss of the sense of smell.

The best treatment in such examples is the constitutional, in the form of tonics, using the one which appears to be most suited to the general wants of the patient's system. Some slight stimulating lotion, such as the sulphate or chloride of zinc, or nitrate of silver, in the strength of two grains to the ounce, may at times be required, but constitutional means alone are generally sufficient. I have one example only from the in-door experience of the hospital of this condition, also sent in as one of polypus, but from my out-door practice many might be quoted. Removal of the turbinated bone for this affection has been advocated and performed by some surgeons, but at present I have not seen any instance where such an operation was required, and should hesitate to adopt the practice, believing that other minor measures will suffice to effect a cure.

It is worthy of observation that this disease is at times confined to the mucous membrane over the lower turbinated bone; the reasons for which fact I am unable to explain.

Ozæna.—We will now proceed to the consideration of another large and important class of cases, which are too frequently treated of under the name of *ozæna*, but which essentially depend upon many different morbid conditions. In all an offensive discharge, or rather smell, is the common symptom, giving rise to the term designating the disease.

I am not aware that it has ever been satisfactorily proved

that this offensive smell is the result of any morbid secretion of the part ; my own experience has not furnished me with any information tending to confirm such an idea, and I believe that the fetor is generally, if not always, the result of the decomposition of the retained mucus ; at times associated with an ulcer of the mucous membrane ; and at others with some diseased bone, the result of syphilis or otherwise. The disease generally progresses very insidiously, and many months have usually elapsed before the surgeon or medical adviser is consulted.

The patient at first believes the symptoms to depend upon an ordinary catarrh ; the discharge from the nose is thick, but not offensive, and the sense of smell is more or less impaired. If these symptoms continue, the health of the sufferer generally declines, and being generally found in weakly and delicate people, the physician is consulted for the want of power, the local symptoms assuming a secondary importance.

If the nose be examined, as it should be, with a speculum, to obtain a good view of the whole, the only morbid condition which will be visible is intense congestion of the mucous membrane ; it will not be much, if at all, thickened, but will be of a deep colour, evidently the result of engorged vessels. This fact is of some value and interest, as this morbid condition is associated with excess of secretion, but in those cases of thickened mucous membrane which have been previously alluded to there is a marked deficiency. The only correct and satisfactory treatment is the constitutional. Improve the general condition of the body, and the local disease will disappear ; to this end consider well the hygienic agents with which the patient is surrounded ; if any be deficient, let the deficiencies be supplied ; if tonics, as quinine or iron, should be indicated, let them be administered. Attend to the secretions, and remove all external and internal causes which may prove detrimental to health.

The local disease may usually be left alone ; it depends upon general conditions, and when these conditions are improved, it may confidently be asserted that the local symptoms will disappear. The inhalation of steam at times will assist the removal of the secretion and relieve the state of fulness of the part which some patients so much complain of.

In other cases the injection of warm water affords relief, especially if the discharges have a tendency to desiccate, adhere to the mucous lining, and, as a consequence, to putrefy; and it is this putrefaction of the retained muco-purulent secretion on which essentially depends the condition denominated *ozæna*. *Ozæna*, then, may be simply the result of a condition like that which has been just described, allowed to progress too far without treatment; and if so, it must be treated on the same principles, the offensive discharge must be constantly removed by means of a syringe used freely, with a good and steady stream; if well done, no muco-purulent secretion will be allowed to remain to decompose, and, as a result, the one most troublesome symptom of fetor will be removed and in future be prevented.

Medicated lotions in such examples are seldom required, although in obstinate cases some slight stimulant, such as the sulphate or chloride of zinc, or nitrate of silver, may be employed, in the strength of about one grain to the ounce of water. This practice I have followed for some years, but it has of late been ably brought before the notice of the profession by Dr. Druitt.

But *ozæna* does not always depend upon such simple local conditions; in some instances ulceration of the passage in some part may be not only suspected, but with the speculum can be observed, and an occasional escape of a blood-stained, muco-purulent secretion should lead the surgeon to suspect the existence of such a condition.

Indeed, it is pathologically correct that such an ulceration should at times take place; inflammation of the Schneiderian membrane is the pathology of the cases we have last described, and at the present time ulceration of the same tissue claims our attention.

The principles of treatment, however, are the same—tonics constitutionally, with cleanliness locally; topical stimulants may be employed when simpler means have failed, or when great indolence of the part is present.

But the retention and decomposition of the morbid secretions being the cause of the fetor, by proper treatment this *ozæna* may be soon destroyed. By constitutional means, combined perhaps with local, the causes or rather pathological conditions

upon which the disease depends may be removed, and a recovery ensue.

Much time, however, is frequently required to ensure such a result, several months being not often too long; but as the fetor is the chief symptom of annoyance to the sufferer, such may speedily be removed by the mechanical and local means already suggested, and thus the worst feature of the disease is destroyed, and the mental as well as the physical comfort of the patient secured.

Let, however, this inflammatory action and perhaps ulceration continue, and a different result will follow. As we see in other parts, so we find in the nose, the bone itself becomes involved, inflammation takes place, and as a result necrosis follows. In so-called strumous subjects this condition is not infrequent, although I have no evidence to give that such a necrosis is always the result of the extension of the inflammation from the soft parts around the bone to the bone itself; in many cases if not in the majority, I believe the disease originates in the bones, for we well know that strumous subjects are very liable to an ostitis and periostitis of a low form, followed by necrosis, whether the result of an injury or otherwise.

In the nose such a necrosis is not an infrequent condition, and is, as a consequence, another cause of the disease described as *ozæna*. It is found in children, as well as in adult life, and may be the result of injury, extension of disease from the soft parts covering the bones, or associated with the so-called strumous diathesis, or syphilitic poison. At times it may take place without any such distinct cause, it being well known that inflammation of the bone in other parts may also arise *per se*, and no visible or positive cause being made out, it is then described as idiopathic.

When produced by necrosed bone, the fetor is generally of a peculiar character, being such as is well known to accompany diseased bone. By careful examination with the speculum or probe, bone will often be detected, whereby the nature of the disease becomes tolerably evident; in early life, I have been lead to believe that inherited syphilis is a more frequent cause than is generally suspected, and this opinion has been made clear by the presence of other marked symptoms, such as old skin diseases, syphilitic teeth, or keratitis.

To form a correct opinion, a careful history of the case must be obtained, and well-known symptoms not overlooked, for unless an accurate knowledge of the cause can be acquired, the treatment to be adopted must be doubtful, and consequently will be unsuccessful.

Treatment.—When the presence of necrosed bone has been made out as a cause of the disease called ozæna, it is tolerably evident that the patient will not recover until the fetid bone has been removed, or rather has exfoliated. To this end the preservation of perfect cleanliness by means of the syringe, with or without stimulating or antiseptic lotions, may be employed, and tonics administered. If syphilis, either hereditary or acquired, is the apparent cause, our remedies must be modified to the general requirements of the patient. Mercurials are seldom necessary, although in children suffering from this disease, where the history and other symptoms of congenital syphilis are present, I have given them, associated with tonics, with marked benefit, and in obstinate cases in adult life such a combination may also be employed. The bichloride or iodide have proved themselves the best forms in my hands, and when combined with other tonics, such as quinine, bark, or iron, they are most valuable. The bichloride I generally give with bark, and the iodide in pills at bedtime, with the syrup of the iodide of iron and the iodide of potassium in some bitter, as quassia. If mercurials are not indicated or required, although syphilis be suspected, the latter recipe of iodide of iron and potassium cannot be too highly praised.

In strumous subjects, perfect local cleanliness, and perhaps stimulants, accompanied with tonics, as cod-liver oil, quinine, iron, or their combination, generally suffice, and a cure may confidently be promised.

CHAPTER II.

ON SURGICAL DISEASES AND INJURIES OF THE LARYNX.

On Foreign Bodies in the Air-passages.

There are few accidents which excite more anxiety and alarm to a looker-on than the passage of a foreign body into the larynx or trachea. The unfortunate subject, from apparent health or happiness is suddenly seized with violent struggles for life, and to all appearances that life is to be curtailed, and its value exchanged for a sudden and painful death.

In the surgeon, not less painful feelings are excited, for unless by his art timely relief can be afforded, the danger which is apparent becomes real, and death is almost a certainty.

The majority of the victims of such an accident are children, although adults are not exempt from such a contingency.

The foreign body may be inhaled at any moment, a sudden inspiration being sufficient when the mouth is full, especially when that foreign body is smooth, light, or small, such as a stone, bead, nut, or coin.

The body may be lodged at the orifice of the larynx, and thus by its occlusion sudden asphyxia may be produced.

But in the majority of instances it passes into the rima, where it may be arrested, or it passes through into the trachea or bronchi, the left being its most common seat.

I have before me eight examples of such an accident; five were three years old and under, and three between the eighth and ninth year.

In all tracheotomy was performed. In five the foreign body was ejected immediately upon the opening of the trachea, and in four of these recovery ensued. In the fifth, everything went on well for three days, when broncho-pneumonia set in, destroying the patient on the eighth day.

In the remaining three cases, although tracheotomy was performed, the foreign body could not be removed, and death ensued.

CASE.—The first was in a child three years of age, who was admitted one hour after the accident, the foreign body being supposed to be a piece of nutshell.

The respiration was much impeded, air at times passing into the right lung and at others into the left, as if the body acted alternately as a valve, occluding by turns each bronchus; no paroxysm of dyspnoea, however, took place. Tracheotomy was performed by a free incision, but without avail, the character of the respiration remaining unaltered; and nine hours after the operation, and ten after the accident, the child died in a paroxysm of coughing.

After death the morbid appearances of acute bronchitis were present, the tubes being filled with tenacious mucus, in some parts completely obstructing the passage of air into the lungs, which were airless. A piece of nutshell was found in the rima, between the cords, and quite moveable, evidently having been ejected so far in the last act of life.

Remarks.—When the trachea had been opened, all means adapted for the removal of the foreign body were employed, such as a violent shake on the back and the dependent position of the head, but without avail. Thinking that the body might be lodged in the larynx, a probe was passed upwards through the rima without difficulty, no obstruction being detected; and, indeed, the general symptoms, or rather the character of the respiratory act, indicated an obstruction beneath the opening, as it was unaltered when the trachea was opened, and this would not have been the case if the obstruction had been above the seat of operation and in the larynx. The foreign body must have been firmly impacted at the bifurcation of the trachea, as there were no symptoms of its having moved after its first introduction, until the final scene. The respiration was impeded from the first, but no paroxysm of coughing ever took place.

It was pathologically interesting to see how rapidly the irritation of the foreign body had excited acute bronchitis, the tubes being filled with tenacious mucus, some smaller ones, indeed, being blocked up, causing complete occlusion of the air, and all this in the space of nine hours.

CASE.—The second was in a boy aged three years, who

accidentally, when at play, inhaled a small haricot bean ; there was some slight difficulty of respiration immediately after the accident, but not sufficient to cause much alarm to the parents, but as this gradually became worse they brought the child to Guy's just sixteen hours after the accident.

When admitted, the respiration was difficult, but steady ; the child's head was thrown back, and its veins somewhat congested ; on examining the chest the right side was completely paralysed, no air passing into the right lung. It was tolerably evident that the right bronchus was the seat of the obstruction. Tracheotomy was at once performed, but without benefit ; the bean did not move, and the child died about forty hours after the operation, and fifty-six after the accident.

After death the right lung was found to be completely collapsed. The whole air-passages were acutely inflamed, the glottis swollen, and the larynx and trachea covered with membranous lymph as in croup, but to a less extent. Firmly impacted in the right bronchus there was a bean, which completely filled the tube ; it was removed with difficulty, having evidently much swollen from the moisture with which it was surrounded. The lungs themselves were healthy.

Remarks.—In this example the unfortunate termination of the case may fairly be set down to the lengthened period which was allowed to elapse before relief was sought ; if tracheotomy had been immediately performed, the foreign body would probably have been removed, as it was of a smooth and easily moveable character, and was not likely to have been caught or entangled by the mucus or other parts ; but as so many hours had passed over before the operation, by its swelling it became completely impacted, and the chance of success by operation was rendered very feeble.

CASE.—The third fatal example which I shall quote was in a child but eleven months old ; one hour previous to its admission, when drinking some broth, it was seized with violent coughing, and this was followed by difficulty in breathing. The symptoms at first were very severe, but they gradually abated ; as the laboured respiration, however, continued, the mother brought the child to the hospital.

Upon examining the chest, air entered both lungs, although

not freely, the respiration was evidently impeded and of a crowing character, and much venous congestion was present.

Tracheotomy was at once performed, although without benefit; the wound was subsequently left open by the dresser, but no indications of any movement of the foreign body showed themselves, and three hours after the operation, and four after the accident, the child died.

After death the lungs and bronchi were found healthy, some little emphysema existed in the anterior mediastinum and around the thymus gland. Sticking in the rima, and projecting through the top of the glottis, was a piece of bone which exactly filled in the space between the vocal cords, and was firmly impacted; no breach of surface was detected.

Remarks.—Upon the conclusion of this case but one feeling could be entertained, and that was of disappointment that a more careful exploration of the larynx had not been made; if any probe or other instrument had been passed upwards towards the rima, the body might have been discovered and its removal ensured; or even if the finger had been passed downwards from the mouth it must have been detected. I am not prepared to say that such measures were not adopted, as I believe they were, but it must have been clear that the means employed were not sufficient, or a different termination might have ensued. The child died quite quietly, asphyxiated, without any paroxysm of coughing, so that the bone could not have been ejected into the position where it was found, before death, as appeared to have been the case in the first example related.

From the consideration of these three fatal cases several practical points present themselves to our notice.

The first, as shown in Case 2, is the necessity of a speedy operation. If such had been performed in that example a different termination might fairly have been expected, for if the body is soft, an enlargement, by simple swelling, is sure to take place; and if the body is light, pointed, or rough, such as a nutshell or bone, by its irritation to the bronchial membrane it is certain to excite acute and rapid inflammation, and the resulting tenacious mucus is tolerably sure to prevent its being ejected.

A second point may also be learned from Case 1, which I

believe should always be acted upon, and that is, when tracheotomy has been performed, and the foreign body has refused to move and to be expelled, the opening in the trachea should be made very free, and its edges either kept open by some mechanical means, or a piece of its anterior surface should be cut out, in order to allow the foreign body to be ejected, should it by some fortunate act of coughing be displaced. In this case it appears that the nutshell, although evidently originally situated at the lower portion of the trachea, was subsequently expelled upwards, and not only passed by the large vertical opening in the air-passages made by the operator, but became impacted in the larynx and caused death; and it is fair to believe that if the plan suggested had been acted upon, the nutshell would probably have passed externally, and a more fortunate termination of the case have been the result.

The third point, as illustrated by Case 8, is of no less consequence than the two others, namely, when the trachea has been opened, a very careful examination should always be made of the larynx, both by the probe as passed upwards through the wound and by the finger as passed downwards through the mouth; in the example quoted, if this practice had been adopted, perhaps a different result might have taken place; at any rate the practice appears to be a good one, and can never do any harm.

Having carefully considered the fatal cases, in which the foreign body could not be removed by tracheotomy, and having drawn a few practical points from their consideration, it may not be without benefit to consider for a few minutes the cases in which the foreign body was removed, and to see if our previous conclusions are in any way supported by the facts in them detailed. There are five examples, in four of which recovery ensued, and in the fifth acute broncho-pneumonia proved fatal on the seventh day.

In the four successful cases the foreign body in two was a cherry-stone, in one a large glass bead, and in one the core of an apple. In the fatal case a nutshell was the offending material.

In one case, the cherry-stone had been in the air-passages for five days, causing at times severe paroxysms of coughing;

it occurred in a boy aged nine years ; the foreign body was immediately ejected upon opening the trachea.

In the case of the bead, in a child eight years old, the operation was performed on the second day, a flap being made in the trachea, including two rings ; and the body, which weighed twenty-seven grains, and was nearly three quarters of an inch long, was rapidly ejected.

In the case of the apple-core, which occurred in a child fifteen months old, and was operated upon six hours after its introduction, the core was removed in the nail of the operator, when introduced downwards through the wound in order to examine it ; the foreign body having been thrown upwards in the act of coughing.

CASE.—In the secondary fatal case, which was in a child fourteen months old, the operation was performed one hour after the accident. The trachea was opened, but no foreign body was expelled ; the larynx was then carefully searched from above as well as from below, and the nutshell was found within the rima, and on being tilted upwards, by means of a probe, it was swallowed and the proof was lost ; the operator, however, distinctly felt it with the probe as introduced from below and with the finger from above.

Everything progressed well for three days, when acute broncho-pneumonia set in and destroyed the patient ; which was confirmed by the post-mortem examination.

By these examples the benefit of speedy relief is well exemplified, although, when the foreign body is smooth, the irritation caused by its presence is evidently less, and longer delay may undoubtedly be tolerated.

In the case of the glass bead, which was three quarters of an inch long, the benefit of a large opening and of a flap in the trachea was well demonstrated ; and in the last case, although a fatal one, the benefit of carefully examining the larynx was clearly proved.

Upon the whole, the lessons to be gained by the consideration of the successful cases are the same as those drawn from the fatal ; one series confirming the accuracy of the other.

It would then appear, as indeed our reason would lead us

to infer from the consideration of these cases, that the smoother the foreign body, the more tolerant of its presence are the air-passages, the greater certainty is there of its removal, and the chance of a fatal inflammation is diminished.

The lighter and more rigid the foreign body, the greater the likelihood of its being fixed in the larynx, the greater its liability to become entangled in the trachea, and the greater the chance of an acute inflammation of the air-passages; and, as a consequence, the probability of its removal becomes lessened, and also the hopes of a subsequent recovery.

CHAPTER III.

ON OEDEMA OF THE LARYNX FROM SWALLOWING BOILING WATER.

The habit amongst the poor of feeding their children out of a teapot, has engendered the not infrequent accident, which forms the text of this chapter. The child, in its anxiety to obtain drink, seeks it from the kettle on the fire, and so scalds the pharynx and orifice of the larynx that oedematous inflammation of the parts follow, in the same manner as a blister would be produced by the application of boiling water to any other tissue.

The symptoms caused by such an accident, as a rule, appear speedily after the application of the fluid, and the small chink in the glottis becomes so rapidly closed, that unless early relief can be obtained, a fatal result must almost necessarily take place.

I have before me notes of twelve examples of such an accident, all taking place in children under three years and a half of age. In two of these the injury was so slight as only to produce some difficulty in respiration, not sufficient to necessitate any operative interference; and recovery took place by simply keeping the child in bed, with warmth externally, and in a warm temperature.

In nine cases, tracheotomy was performed, and in five of

these with success ; in the remaining four a fatal result ensued. In one the symptoms were so slight that an operation was not deemed requisite, but a sudden attack of spasm took place half an hour after its admission into the hospital, and two hours and a half after the accident, which put an end to life.

CASE.—The child was three years and a half old ; the respiration was difficult, but not laborious, at any rate not sufficiently so to induce the surgeon to perform tracheotomy. At the post-mortem, the mucous membrane covering the pharynx and epiglottis down to the superior vocal cords was shreddy, œdematous, and thickened, and the larynx contained a frothy mucus. The trachea and bronchi were congested, and filled with mucus. The lungs also were gorged with blood. The cervical veins were much distended. Heart healthy, with right side full of blood. Viscera healthy.

Remarks.—It is hardly fair to say, that if an operation had been performed in this case, a successful result might have been obtained ; nevertheless it was so believed by some who had watched it and had regarded the post-mortem appearances. Death had evidently been caused by a sudden spasm of the laryngeal muscles, and not by the rapid or gradual mechanical closure of the glottis by the œdema of the parts. To my mind, the lesson to be learnt from the case was not to delay the operation too long. If the case is not very threatening in its nature, but becoming worse, do not wait till the lungs and veins are all turgid with blood, and consequently are all disposed to inflammatory action, and are certainly not favorable to recovery ; but operate at once, and thus put an end to the great risk of all these cases of œdema of the glottis, namely, spasm and sudden death.

In the following case death was imminent by the spasm of the larynx coming on during the operation, and life was saved only by opening the trachea. It is true that death subsequently ensued from broncho-pneumonia, but this does not interfere with the value of the practice.

CASE.—A child, æt. $3\frac{1}{2}$, was admitted into Guy's, eight hours after drinking boiling water from a tea-kettle, with all the

symptoms of approaching asphyxia from oedema of the larynx. Tracheotomy was at once performed, and during the operation a most violent spasm took place, followed by the cessation of respiration; and it was only after the long-continued action of artificial respiration that life was prolonged. Relief speedily ensued, and no bad symptom made its appearance. On the fourth day the canula was removed, and the child appeared convalescing. On the eighth day it was as cheerful as usual, ate, drank, and slept with all the symptoms of health, and its voice had quite recovered its natural tone. On the tenth day, however, it suddenly lost its voice, became hoarse and feverish. Inflammation of the lungs rapidly came on, which, on the fifteenth day, proved fatal.

After death all the evidences of acute inflammation of the whole air-passages were seen. The mucous membrane was acutely inflamed, and the tubes were filled with mucus, the lungs themselves being also involved.

Remarks.—In this case the cause of death was too clear, but it is hardly fair to assign it altogether to the accident or to the operation; from the immediate effects of both, recovery had apparently taken place, and no single sign of mischief remained except the granulating wound in the neck from the operation; the opening in the trachea had closed for some days, as the voice was natural and free from all indications of obstruction. The inflammation of the air-passages I am disposed to regard as accidental, the original injury and operation having increased the tendency to such an attack.

In the case which I propose now to relate, a complication was present which I have observed in several instances, namely, the appearance of the milk which the child drank at the orifice of the canula, and which had evidently made its way down the larynx, and been expelled through the artificial opening.

CASE.—A boy, æt. 18 months, was operated upon twelve hours after the swallowing of the boiling liquid, the symptoms having gradually become worse; everything progressed well for three days, when acute broncho-pneumonia appeared, proving fatal on the fourth day. Twelve hours after the operation

milk was first observed at the tracheal opening, and on many subsequent occasions the observation was repeated. In many like instances the same appearances have presented themselves, and it only remains to find an explanation of the fact.

Remarks.—I well remember the alarm which such a symptom excited in the mind of a surgical friend when he first observed it, as the fear had passed through his mind that the œsophagus had been wounded during the operation, and that such a channel allowed the milk to pass through. This fear is, however, completely groundless, as repeated observation has convinced me of the fact when no such error had been committed, and I believe the milk is allowed to pass, simply because the epiglottis and glottis are so injured as to cease to act as valves, and have also by the scald become so blistered, and thus insensible to impressions, that a foreign body may pass without exciting any irritation. The fact, however, remains—the milk does pass, and that without exciting cough or other signs of irritation, unless in large quantities, when it passes downwards into the tubes and excites cough.

In the case just quoted it was a question in my mind whether it might not have been the irritation of the milk and other food which had subsequently excited the inflammation of the lung; at any rate, it must have considerably aided this result.

At the post-mortem the epiglottis and glottis were found to be somewhat swollen, but not to any great extent; the whole air-tubes were inflamed and filled with mucus; the right lung was completely consolidated, the left lower lobe partially so. The remaining viscera were healthy.

When there are symptoms of milk or food making its appearance at the orifice of the canula, it becomes a question whether it is right to give fluid by the mouth, and whether it would not be better to feed the child through a tube passed down into the œsophagus. I am disposed to believe it would, and in another case I shall be disposed to adopt the practice.

The five successful cases possess no points of special interest; in one only were there any signs of pneumonic mischief, which was treated by small doses of antimonial wine with marked success; in the remainder everything progressed

as favorably as could be desired. The canula was removed at the end of three, three, five, eight, and twelve days respectively, that is, as soon as the larynx allowed the passage of air. This rule is especially worthy of attention, as a canula can only be regarded as a foreign body, and the sooner it can be dispensed with the better. By way of summary—

In such accidents, if the symptoms are increasing and of any severity, operate at once, and remove the tube on the earliest opportunity; if symptoms of pneumonia appear, treat it with antimony, although with care; and if the larynx allows the food to pass downwards into the trachea, consider whether it would not be the best practice to prevent such a contingency taking place, and feed the patient through a tube passed downwards towards the stomach.

Delay in operating has been shown to be dangerous by the cases related, and although there is always danger in the operation, and more particularly danger from pneumonia, tracheotomy should be performed. It is difficult to say how much of this pneumonia is due to the accident and how much to the operation; the operation, however, appears a necessity, to remedy a temporary mechanical obstruction to respiration, and unless that obstruction can be removed, death is imminent. Surgeons of late have suggested the propriety of scarifying the œdematous mucous membrane. If such can be done with facility and with success, the propriety of such a measure cannot be doubted. I have no personal experience to give upon this matter, and can only therefore recommend the consideration of the subject to my surgical brethren.

CHAPTER IV.

ON TRACHEOTOMY, AS REQUIRED IN ORGANIC DISEASES OF THE LARYNX OR ITS NEIGHBOURHOOD.

It is not my intention to enter upon the extensive, but interesting, subject of organic disease of the larynx; nor to dwell long upon the pathological conditions which may require such an operation as tracheotomy or laryngotomy; but

as every practical surgeon must at times have been called upon by the physician to come forward to his assistance, and to do his best to prolong the life of his patient by the opening of some portion of the air-passages, I hope to be able to illustrate this part of my subject by some few interesting cases, and to bring out by their consideration some points worthy of attention.

When the anatomy of the larynx and the delicacy of its structure is considered, it is easily understood how any disease producing a thickening of the glottis, or of the rima, should excite symptoms of suffocation; and that chronic inflammatory conditions affecting these parts, whether involving the cartilages, soft parts, or both, cannot continue for any lengthened period without affecting more or less the function of respiration.

Under the name of strumous or syphilitic disease of the larynx, the majority of the cases of chronic inflammatory affections of the larynx are generally grouped; it is for such that the surgeon is often consulted with the view of some operative interference, and it is in such that his assistance is often of great value.

There are other affections of the glottis which may also require surgical treatment.

Inflammation and ulceration of the soft parts around the cartilages may be caused by ossification and the subsequent death of the cartilages themselves, and in these instances tracheotomy may be demanded.

Warty and other growths, whether simple or malignant, may grow from or involve the upper portion of the larynx; and thereby obstruct the respiratory effort and require a like surgical interference; and lastly tumours originating external to the trachea may so enlarge, press upon, and impede respiration, that the opening of the trachea may be called for.

But whatever the pathological conditions may be which cause an obstruction to the respiratory act; and however interesting the study of such must ever be to the scientific surgeon, in practice these distinctions become of small value, as the assistance of the surgeon is commonly required in an emergency, and he is called upon by his art to prevent, what is too evident, asphyxia and a rapid death. Under such cir-

cumstances all pathological distinctions are put aside, and it remains only for the surgeon to decide whether he will stand by, with his hands folded, and watch the victim of disease gradually asphyxiate, or by his art open the trachea, and thus do his best to prolong, if not to save, the life of the sufferer. It is true that the position of the operating surgeon in these cases is one of difficulty, as his knowledge too often tells him that the operation can but briefly prolong the life which may be an agony ; but the laws of our profession and of humanity are fortunately binding, and it is not for us to judge of the expediency of the measure, but at all hazards to advise and to carry out such measures as offer a fair prospect of temporary relief and of prolonging life. Under such circumstances laryngotomy or tracheotomy should be performed, and it remains for me briefly to quote a few examples illustrating this interesting subject.

CASE.—Syphilitic disease of larynx, requiring tracheotomy ; canula worn for twelve years ; foreign body in trachea ; opening enlarged ; recovery.—Sarah C—, æt. 28, was admitted into Guy's Hospital on June 16th, 1847, under the care of Mr. Hilton. She was a pale, cachectic-looking woman, who had lived very irregularly, and had had syphilis. On admission her throat was extensively ulcerated, and the larynx was evidently involved ; her breathing was stridulous, and 13 in a minute. As her symptoms rapidly became worse, and as suffocation appeared probable, tracheotomy was performed. For some days afterwards her cough was most troublesome, the mucus at times obstructing the tube, but these symptoms soon subsided, and at the end of the third week she was able to get about, and appeared convalescent. The ulceration of the soft palate gradually healed, her strength improved, and seven weeks after the operation she left the hospital, still wearing the canula.

Six years subsequently the patient was again admitted into the hospital for some bronchial affection ; in the interval she had married and had borne three children. The means of subsistence having been very scanty during this period, she had undergone much privation, and had been exposed to all the changes of temperature. Slight attacks of bronchitis had at

times oppressed her, but she would never take any care of herself, nor wear any light covering over the orifice of the canula. The tube had been cleaned every four months, and more frequently when the mucous secretion was very copious, which passed freely through it; none whatever, not even air, passing through the larynx.

At the interval of another six years she was again admitted, having in the morning, when cleaning out the tube with a piece of twisted tape, broken off the end, leaving it in the trachea; she immediately was seized with difficulty in breathing, and went off to Mr. Hilton's residence, who sent her on to Guy's. She was admitted under my care, and as it was found impossible to remove the body without enlarging the artificial wound downwards, such an operation was performed; the rings in the trachea being very hard; the foreign body was at once expelled, and all difficulty in respiration ceased. Everything progressed well, and in a few days she returned home convalescent.

Remarks.—This case must be regarded by every one as of peculiar interest; there was little doubt as to the nature of the disease, as a syphilitic history was tolerably clear; there could have been none as to the propriety of the operation, as death appeared imminent; and the success of the treatment is well proved in the lengthened period of life which has been vouchsafed to her.

The opening of the glottis appears to be completely closed, not a particle of air being allowed to pass, and it is a subject of interest to watch her in her efforts to articulate and make herself understood; of course this is done merely by her mouth, but she shapes her lips so well that it is not difficult to understand all she says.

The fact that this patient has worn the tube twelve years and upwards is a proof that the trachea becomes at last very tolerant of a foreign body, and also that the body itself is well adapted for its purpose. The shape of the canula is exactly similar to that which is ordinarily employed. The occasional attacks of bronchitis are in a great measure due to her carelessness and necessary hardships of her life; she is very poor, with a large family, and will not take the trouble to wear even a muslin shade over the tube, even in the coldest and dustiest weather.

I know of no case more encouraging than the above, and have therefore given this somewhat extended account.

In the case just quoted tracheotomy was performed as the disease appeared extensive, and it was thought more desirable to operate on the trachea and thus be sure of being below the seat of the malady; such a practice, however, is not always necessary, and when the disease appears confined to the upper portion of the larynx, involving only the opening of the glottis or vocal cords, the operation of laryngotomy should be selected, as being a simpler and equally efficacious operation.

In the following example such a practice was adopted, and well displays the benefit of the practice employed.

CASE.—A man, æt. 30, of a healthy constitution, contracted syphilis in 1850; in 1855 the constitutional symptoms had not left him, and in August, 1859, he first observed some huskiness in the larynx and occasional pain. He thought little of it at the time, but as it gradually became worse and caused some difficulty to respiration, he was admitted into Guy's Hospital under the care of Mr. Cock. When seen, there were no general symptoms of constitutional syphilis. He was a healthy looking man, and the only symptom which was to be observed was a laboured breathing, evidently the result of contraction of the laryngeal orifice. The parts about the larynx were slightly thickened, but not to any great extent, and manipulation gave no pain. He was carefully watched for some time; indeed, nearly four months elapsed before any operative interference was imperatively called for. Laryngotomy was then performed by Mr. Poland with great benefit. His respiration became quite natural, and no bad result ensued, the man leaving the hospital some weeks afterwards, wearing the tube.

In this example the disease was evidently located at the orifice of the larynx; some ulceration had existed, and by its subsequent cicatrization contraction of the orifice, if not closure, was threatened. The operation of laryngotomy was in this case unquestionably to be selected, and the benefits accruing from the operation justified the step.

CASE.—I have the notes of a third case, which is equally favorable, and which equally indicates the value of tracheotomy; it occurred in a man aged forty-two, who was admitted in a dying condition from obstructive disease of the larynx, a history of syphilis being tolerably clear. Tracheotomy was at once performed, and a rapid convalescence followed. At the present date, three years and a half after the operation, he is in good health, with the tube constantly in, the larynx being completely closed.

In the three cases which I have quoted a syphilitic poison was evidently the original cause of all the mischief, and it is in such examples that the benefit of laryngotomy is well demonstrated; the local symptoms produced by the disease, although serious and threatening life, are remediable; and by treating the local disease together with the constitutional, the immediate danger may be counteracted, and time be given for remedies to act; thus in a measure neutralizing the systemic affection. By the operation, rest is given to the part, and the healing process is consequently encouraged. Whenever ulceration of the larynx arises from such a constitutional cause as that which is generally described as struma, the same good results cannot be shown, and I am unable to quote from my own experience a single example in which tracheotomy has been performed and life saved, that is, extended to a degree equal to the last cases which I have given.

I can quote a case where death was delayed by the operation, and where the patient's last days were rendered more endurable; but the local disease continued as well as the more general, and destroyed him twelve days subsequently. Such a result is only that which must, as a rule, be anticipated. For this form of ulceration of the larynx is generally but a symptom of a constitutional phthisical tendency, and is almost always associated with some pulmonary disease; under such circumstances death from the local disease may be for a time delayed, but the deeper-rooted mischief still continues, and must eventually destroy.

CASE.—A woman, æt. 36, was admitted into Guy's Hospital under the care of Dr. Rees, with some laryngeal affec-

tion of ten months' duration. She was much emaciated and very feeble. Her voice was scarcely to be heard, and of a harsh character, so much so that she was with difficulty understood. The larynx externally appeared to be much thickened, and the integument over it was the seat of a strumous ulceration. She had incessant cough and expectoration, swallowed fluids only, and those with difficulty. There were marked symptoms also of some extensive pulmonary disease.

As the respiration became worse, and death from suffocation threatened, I was called upon to perform tracheotomy, which was followed by satisfactory results; her respiration was rendered easy, she took food freely and with relish; she slept well, and was comparatively greatly relieved. But such benefit continued only for a few days; pneumonic mischief developed steadily and rapidly, and on the twelfth day she sank.

At the post-mortem examination the following conditions were detected :

The larynx was most extensively diseased. The right side of the epiglottis and vocal cord was entirely destroyed by ulceration. The right ala of the thyroid cartilage was exposed and of a green colour, portions being ossified and detached; the right half of the cricoid was necrotic and lying in a sloughing cavity, and externally a sloughing abscess existed surrounding the diseased portions.

The opening in the trachea was healthy. The tubes were inflamed, and their mucous lining of a green colour. The lungs were inflamed, masses of consolidated tissue being scattered throughout, some softening down, and one, the size of an egg, had become gangrenous.

Remarks.—In this case, however, the operation of tracheotomy afforded all the relief that was to have been expected—it delayed death and smoothed the pathway for the patient; extensive organic pulmonary disease coexisting, no more could have been anticipated, and the surgeon's art in this, as in other instances, was exercised more to alleviate than to remedy. It is not, perhaps, agreeable to that man's pride who would fain conquer and overcome, but surely the professional man's mission is not the less perfect when employed to retard the progress of disease, to alleviate its miseries, and to render that

death which is inevitable less painful and perhaps less rapid. It is by such acts that our profession confers the greatest blessings, and as surgeons we must as often operate to carry out these intentions, as to save life, and by so doing perform our duties.

I have thus, by cases upon which I have based a few remarks, illustrated the benefits which may be expected from the operation of tracheotomy or laryngotomy in ulcerations of the larynx, whether the result of syphilis or the concomitant of some phthisical disease; and have shown that in the former, if the constitutional powers are good and the chief disease is local, that a considerable extension of life, if not a cure of the disease, may with some confidence be anticipated. I have also expressed an opinion, and illustrated it by a case, that where this laryngeal disease is only a symptom of a more serious general affection, the operation, although equally called for, can only relieve, and that if it delays death only for a short period and relieves suffering its object is fulfilled.

I am by no means prepared to say that it is only in these two classes of cases that ulcerations of the larynx are to be found which require operative relief; I believe that they may take place independently of these constitutional tendencies, although it has never fallen to my lot to witness such severe instances, requiring a like treatment. There certainly is no reason why simple ulceration should not attack the mucous lining of the larynx, as it may attack other parts, unconnected with syphilis or struma; and there can be little doubt but that instances occur; although they may rarely extend so far as to necessitate the opening of the air-passages. Primary disease of the laryngeal cartilages may also exist, whether the result of their degeneration and death, or of any constitutional affection; giving rise secondarily to abscess and laryngeal obstruction, which may require operative interference.

But this is not the place to enter into the pathological conditions of the larynx which may require surgical aid; whenever disease of the larynx has so extended as to interfere with life's vital function of respiration, an operation for opening the air-passage must be performed, with the in-

tention of prolonging life, if not of curing the disease. I have before me three other examples where this operation was performed, and with only that view, death having been postponed but for a few days.

But affections of the larynx itself are not the only diseases which, by obstructing the air-passages, may require the surgeon's aid. Tumours growing externally to these parts may so encroach and press upon the trachea or larynx as to form an equal impediment, and the only means for relieving our patient may be by tracheotomy.

The following example is a good one, as illustrating such a condition, together with the beneficial results of such a practice.

CASE.—George W—, æt. 10 years, was admitted under my care into Guy's Hospital, on January 19th, 1860. He had been ill for two months with some enlarged glands beneath the jaw, and one month previously had observed a tumour situated in the median line over the trachea. For two weeks he had experienced some difficulty in respiration, and as this difficulty had rapidly increased, threatening suffocation, he came to Guy's.

When admitted, his respiration was most laborious and his face congested. In the median line, covering in the whole larynx and trachea, was a tumour, which extended equally on both sides, completely masking from view, even from examination, the larynx and trachea. As there was no doubt that life would soon be extinguished unless relief could be obtained, an incision was made in the median line through the centre of the growth; this was of a firm, fibrous character, and in the centre appeared to be breaking down, as some débris of structure escaped. The trachea was pressed completely backwards, and was found with difficulty, some care being required to open the tube. When this was accomplished, immediate relief was afforded to the patient. A wire splint round the neck was fastened at its ends to the canula, to keep it in its position, as from its deep situation in the wound it was readily expelled on swallowing or on elevation of the larynx. Everything went on well, the tumour appeared gradually to disappear, and the boy's health to improve; on the twelfth day the tube was removed, the boy breathing without difficulty; the wound rapidly

healed, and he left the hospital convalescent, with some evident enlargement in the situation of the thyroid gland and its isthmus.

Remarks.—In this example of disease external to the larynx, impeding respiration, the operation of tracheotomy was imperatively called for, as asphyxia rapidly threatened the life of the patient. Its success was far beyond my most sanguine expectations, and the rapid subsidence of the tumour was as unusual as it was satisfactory. The character of the tumour which so rapidly lessened is still a subject of speculation; it is to be regretted that I did not, when the patient was under the influence of chloroform, excise a small portion for microscopical examination, and thus have learnt its true character.

It appeared to me, at the operation and on subsequent occasions, to have been connected with the thyroid gland, and it seems probable that it really was an acute inflammatory engorgement of that organ; its rapid, although not entire, disappearance pointed to such a pathology; it was exactly in the seat of the gland, which was fixed and immovable.

The pathology of the thyroid is so little understood that probably this opinion may find many questioners; at the same time, from the history of the case as a whole, the situation of the tumour and its subsequent subsidence point more to the truth of this opinion than to any other, as it is quite against all our experience and knowledge to see a new growth, composed of new products, rapidly disappear, particularly when it had enlarged to such an extent as in the case just quoted.

Cases like the above are not numerous; they can occur only now and then. I have one other instance where relief was obtained by tracheotomy for a large cancerous tumour of the pharynx, pressing on the pharyngeal opening, but the man survived only three days. Nevertheless the operation was imperatively called for, and answered all its expected purposes.

CHAPTER V.

ON WOUNDS OF THE THROAT.

However accustomed the mind of a surgeon may be to the contemplation of injuries, the horrors connected with the wounds of the throat can hardly ever be regarded with complacency or without emotion.

If it be the act of the suicide, the mental condition of the sufferer adds with considerable power to the intense interest of the scene; and when the result of a criminal attack upon life, that interest is by no means lessened.

To nerve himself against the emotions which such a scene must excite, it becomes absolutely essential that the surgeon should dwell seriously beforehand upon the necessities of these cases, and thus in the hour of danger be prepared to act with energy and efficiency, by applying his skill to the exigencies that may arise.

I have before me the notes of 36 instances; in 22 of these the wounds were of a superficial character, merely dividing the integuments and superficial muscles, and not, therefore, endangering life.

In 10 cases the wound was situated at the side of the neck, in one above the os hyoides, in 10 between the thyroid cartilage and hyoid bone, and in one over the crico-thyroid membrane, but not dividing it. In only one of these did death take place, and that was the result of delirium tremens, in a fit of which he inflicted the injury.

In no one of these instances did any bleeding or important symptom show itself, the wounds being of a simple character. They were treated also by simple means, the edges brought together by sutures or strapping, and water-dressing applied.

Of the 14 examples in which the wound was of a severer nature, a very different result must be told, as in 7 of them a fatal termination ensued :

In 2 the wound was above the os hyoides.

- | | | | |
|---|---|---|---|
| 4 | „ | „ | between the os hyoides and thyroid cartilage. |
| 3 | „ | | passed through the thyroid cartilage. |
| 2 | „ | „ | „ crico-thyroid membrane. |
| 3 | „ | „ | into the trachea. |

In 4 cases only was there any hæmorrhage of sufficient importance to require the application of a ligature; in 2 of these death followed, in one evidently from the flow of blood: the fatal result—with this exception—being produced by other causes, the victims, as a rule, generally sinking.

To illustrate the dangers of a cut throat, the following cases may be quoted.

CASE.—An intemperate man, æt. 31—having for two weeks been under the influence of drink—after a domestic disturbance inflicted a severe wound in his throat above the os hyoides; some hæmorrhage followed, and in a delirious and half-conscious condition he was brought to the hospital. He was able to speak, and attempted to describe the method by which he had inflicted the wound; in doing so he suddenly became nearly choked, evidently by the divided tongue falling downwards upon the opening of the glottis. To prevent such a result, the dresser pulled his tongue forwards, and having passed a ligature through it, fastened the ends over the man's head. In two days the patient sank.

The necropsy revealed the extent of the mischief. The incision passed round the throat, above the hyoid bone, completely dividing the root of the tongue from its hyoid attachments, the anterior portion being only fixed by its lateral connections. The root of the tongue formed a loose flap, or valve, which covered over the epiglottis, and would evidently have caused suffocation if mechanical means had not been employed to keep the tongue forwards.

The carotids and their branches were untouched.

Remarks.—Such a complication as the above can only take place when the wound is inflicted above the hyoid bone, and is of a severe character; it was fortunate that assistance was at hand, as the man would undoubtedly have been asphyxiated by the tongue falling downwards and thus closing the glottis. The means employed to prevent such a result were unquestionably the best, and the case is quoted here merely to illustrate the contingency, and the correct practice to be adopted in like instances.

As an illustration of death from bleeding, the following is a sad one.

CASE.—A healthy man, æt. 21, was admitted into Guy's for some contused wound over the patella; from this he was convalescing, when, without the slightest indications of any mental distress or other cause, he cut his throat, dividing the thyroid cartilage, crico-thyroid membrane, with the superior thyroid artery, laying open the pharynx and trachea. The bleeding was profuse, and passing downwards into the trachea and œsophagus, produced sudden death from asphyxia.

Remarks.—This case is an example of a not unfrequent cause of death in cases of cut throat involving the larger vessels; the carotid and its branches are not, however, often divided; if they are, the immediate hæmorrhage must rapidly destroy; but if any small bleeding takes place, and the blood should flow into the trachea or respiratory passages, asphyxia must rapidly ensue. The example above quoted is a melancholy instance of such an accident.

The treatment to be adopted in such accidents is the next thing to consider, and indeed its simplicity is most remarkable. It is needless to say that if vessels are wounded they are to be tied, and all measures adopted to prevent any recurrence of the bleeding. That if the tongue should be divided from its hyoid attachments, as in the case quoted, the means there indicated should be employed to prevent suffocation. That if the wound be above the thyroid cartilages, and the epiglottis be incised, there may be a fear of the divided portion obstructing the rima, and thus asphyxia be produced. In such instances some measure must be employed to preserve the divided portions *in situ*, and a ligature or suture appears to offer the greatest advantages—a fine one being passed through the base of the divided portion, and fixing it to its natural position.

In other cases, where the larynx or trachea is wounded, the aim of the surgeon must be directed to keep the divided tube in continuity, and not to allow the upper portion to overlies the lower, and thus obstruct the respiration; at the same time the surgeon must do his best to keep the wounded parts sufficiently open to allow of the escape of the mucus, which is sure to be profuse, and to permit the free ingress of air.

Unless the wound be very extensive and there be difficulty

in carrying out the above indications, sutures are not generally required; the judgment of the surgeon and the exigencies of the individual case will sufficiently point out to the thoughtful practitioner when they may be necessary. In large wounds, where the parts cannot be kept together, a suture is often of immense benefit, and when applied they should be firmly so, including often the whole thickness of the tissues. Their object can only be to fix the divided parts in position, and to prevent by their sudden movement any mechanical obstruction to the respiratory act; to do this effectually, the measures to be employed should be boldly executed. The head should be kept forwards by the application of bandages, and water dressing applied to the wound itself; constant attention is demanded by the nurse to keep the wound clear of discharge and to see that no obstruction to breathing should take place.

As regards nourishment, abundance should always be provided, although it is not such an easy task to get the patient to take it.

When the pharynx or œsophagus is extensively opened, the patient should never be allowed to swallow, and he must be fed by means of a tube passed either through the nose or mouth, and directed with the finger carefully down the throat into the lower portion of the œsophagus. Through this, beef-tea, eggs, brandy, and other liquid nourishment, such as the symptoms indicate, must be administered periodically.

I have an instance before me where the pharynx was extensively opened above the os hyoides, and where the patient was kept alive by such means for nearly six weeks, the tube having been passed through the nose; at the end of this time he was able to swallow, and recovery ensued.

When acting as dresser to the late Mr. Aston Key I had a case where the wound was inflicted through the trachea, dividing the œsophagus; in such an instance the man was fed twice daily through a tube passed through the mouth and directed with care into the lower œsophageal opening; this practice was carried on for many weeks, and was rewarded by recovery. The plan of treatment as just indicated, however, is only rational, and is such as any surgeon would naturally suggest,

CHAPTER VI.

ON INJURIES TO THE THORAX.

The diseases and injuries of the nose and larynx requiring surgical assistance having been briefly illustrated, and examples quoted indicating their various morbid conditions and the correct treatment by which those conditions should be met; it remains for me to review in a like manner the injuries to the chest, and to educe from their consideration some rules of practice which, having proved successful in a large variety of cases, may confidently be recommended in similar instances.

Fractures of the ribs will first engage our attention, and we will then proceed to consider the various complications which may be associated with such an injury.

SECTION I.

On Simple Fracture of the Ribs.

Basing my remarks upon the notes of such cases as have passed beneath my own observation, I find that I possess 108 examples of simple and uncomplicated fracture of the ribs. In some instances the number of ribs involved were very numerous; in others one, two, or three alone were fractured; in none, however, were there any symptoms of emphysema or of injury to the lung.

The seat of fracture was very variable, the majority of cases taking place from a direct blow; the angle or centre of the rib was the usual seat, but the sternal extremities were by no means rarely involved.

In eight of these cases alone, or in 7·4 per cent., did any subsequent inflammatory affection of the pleura or lung make its appearance, and in two of these a fatal result ensued.

CASE.—One case was in a man æt. 55, who had been distressed by an old bronchitis for some years. Having fractured his left ribs by a fall upon his side, a bandage was applied. In twenty-four hours acute broncho-pneumonia set in, from which he sank on the seventh day.

The post-mortem revealed a fracture of his left sixth, seventh, and eighth ribs, about their angles, together with the evidences of chronic bronchitis and recent pneumonia, with granular kidneys. There was no evidence of any injury to the lung from the accident.

Remarks.—In this instance the fall and fractured ribs undoubtedly occasioned death; but would not any other accident have been followed by the same result? A man with diseased kidneys and old pulmonic disease always stands, as it were, upon the brink of a precipice, and the slightest injury or accidental affection carries him down.

CASE.—The second example is not unlike the preceding one; it took place in an intemperate carman, æt. 37, who fractured, from a fall, his fifth, sixth, and seventh ribs, about their angles, two days before applying for advice. He had continued at his work during this period, having been drunk more or less all the time. Prior to his admission he brought up about "two" or three pints of blood, but it could not be accurately made out whether it was by vomiting or coughing. When admitted there was great difficulty of respiration, and universal bronchitis. He was bled from the arm, and antimonials, with salines, given to him, with great relief, but the hæmorrhage continued all night, and he died the next morning.

After death the remains of an *old* apoplectic clot was detected, about the size of a nut, situated on a level with the roof of the right lateral ventricle. The brain was otherwise healthy. The left fifth, sixth, and seventh ribs were fractured about their middle, but no displacement had taken place. The right lung was adherent and the pleura thickened, indicating old disease. The bronchi were inflamed, the mucous membrane being deeply injected; the tubes were filled with a frothy mucus, and the lungs were in the first stage of pneumonia. Above the aortic valves was an aneurism, the size of an egg, communicating with the aorta by a large, round opening, its walls being continuous with those of the aorta; it was empty and free from clot, its lining was very thin, but no opening could be detected in it. The viscera were healthy.

Remarks.—From such a condition of body no surprise could be entertained that death should have followed upon

such an accident as fractured ribs. The source of the hæmorrhage could not be made out, and therefore remains a mystery. The stomach and lungs were free from any extravasated blood, and although a careful search was made, no other part gave evidence of any mischief as would explain the hæmorrhage.

The case is quoted here, however, simply as an example of death after a simple fracture of the ribs, although not from it.

In the remaining six cases, which were complicated with some pulmonary inflammation, all the symptoms were subdued by the free administration of antimony; in one alone was any mercurial combined, and in one only was there a preliminary bleeding performed.

In the majority of such cases the effect of antimony is very striking, given in the form of the wine, in twenty- or thirty-minim doses, every three hours. The pulse becomes lower, the respiration less hurried and more easy, and the skin soon takes on a free action; when this occurs let the dose be diminished or given less frequently, as by such means the patient is generally relieved and the disease arrested.

The treatment of these cases of simple fracture is very simple; the aim of the surgeon is to keep the ribs at rest, and thus allow nature to repair the mischief; this used to be sought for by the application of a bandage firmly rolled round the chest, but experience has taught that this practice is not only a very uncomfortable, if not a painful one, but that it has the great disadvantage of confining and restraining the action of both sides of the thorax. The plan which is usually employed at Guy's Hospital, and which I most strongly recommend, is the application of long strips of thick plaster, about one and a half to two inches broad, and long enough to extend from the spinal column to the sternum, each strip when applied overlying the one above for half its width; by this means the injured ribs are kept absolutely at rest, whilst those of the sound side are left free; there is little or no inconvenience from the application, and it is more durable and more efficacious than the old one of a bandage.

SECTION 2.

On Fractured Ribs and Emphysema.

Having thus briefly dwelt upon the cases of simple fracture of the ribs, uncomplicated with any other local injury, and shown by statistics that it is by no means a fatal accident, unless taking place in patients so diseased that the slightest interference with any of the bodily functions is likely to terminate in death; and having also alluded to the valuable remedy of antimony in the treatment of such pulmonary inflammation as takes place in but a small per-centage of the cases under consideration; I now pass on to consider those cases of fractured ribs complicated with emphysema, but not associated with any hæmoptysis or other symptom of injury to the lung itself; and in doing so the evidence which I can bring forward is nearly as satisfactory as it was in the former class of cases.

Simple emphysema and fractured ribs are by no means a very fatal combination, although it would appear, as it might fairly be anticipated, that a secondary pulmonary inflammation is a more frequent complication than is found to exist in the former simpler cases. The fact that emphysema is present is a sufficient proof that the lung itself is injured, although that injury must be very slight if the emphysema alone is the only symptom of lung mischief. In sixteen examples which I possess, such, however, was the case; in nine of these no bad result followed; the emphysema was variable in its extent, and occasioned but little distress. The side was bandaged or strapped up, and all the symptoms gradually disappeared, the patients convalescing without a bad symptom.

In three cases some cough accompanied the accident; it was but slight and was readily relieved by anodynes; and in four instances, or in 25 per cent., evident symptoms of inflammation of the lungs existed. These were, however, speedily and efficaciously subdued by the antimonial treatment; twenty or thirty drops being given every four hours, with a sedative in the form of Dover's powder at night. Perfect rest was preserved, and abundance of bland, nutritious food given; by such measures I know of few cases which afford greater gratification to the surgeon, as the patient from great distress becomes speedily relieved, and all danger rapidly subsides.

SECTION 3.

On Fractured Ribs and Injury to Lung.

The next class of cases which claims our attention is of a much more severe nature, and as a consequence is much more fatal in their result, as it includes all those instances of fractured ribs associated with evident symptoms of injury to the lung, as indicated by the presence of emphysema and pulmonary hæmorrhage. I have twelve examples of such an accident, and in six a fatal result ensued. In three cases, although the evidence of injury was very clear, and the hæmoptysis and emphysema by no means trivial, no bad symptoms showed themselves. The patients were kept at rest, support was given to the chest by strapping, and simple, unstimulating food administered; which treatment was rewarded by a rapid and perfect recovery. In three others the injury was very extensive, and severe inflammatory symptoms made their appearance; they were actively treated, in two by antimony, and in one by bleeding and antimony, with a good result. The following notes of one of the best examples will perhaps well illustrate the value of the practice.

CASE.—A boy, æt. 19, when riding on the shaft of a waggon laden with two tons' weight of leather, fell, and the wheels of the cart passed completely over his chest. Intense dyspnœa and hæmoptysis immediately ensued, followed by collapse; and in this condition he was brought to the hospital. On an examination, made as carefully as the case warranted, five or six of his left upper ribs were found to be fractured near their costal cartilages, and the sternal end of the left clavicle was thrown forward. Strips of adhesive plaster were applied round the thorax to preserve the ribs at rest, and the boy was placed in bed. When reaction had taken place, antimonial wine ʒss, and opium ℥v, were given every three hours. The dyspnœa becoming worse, and suffocation from pulmonary congestion evidently threatening, I was called to see him, and suggested venesection. This was done to ten ounces, with immense and immediate relief, the boy gratefully

acknowledging it, and stating that he felt all right again. The pulse became smaller and more compressible, the respiration quieter, and the dyspnœa disappeared. The antimony was still continued. For some few hours all went on well, but at the expiration of that period the urgent symptoms returned, and twelve hours subsequent to the first bleeding were nearly as severe as ever. Under these circumstances the operation was repeated, and with the same result. Twelve ounces of blood were withdrawn in a full stream, the blood flowing until the symptoms were relieved. The breathing then became tranquil and quite soft, the boy being again left, with the antimonial treatment, comparatively comfortable. From this time all went on favorably, no return of the dyspnœa appeared, the cough gradually subsided, and the symptoms of returning health made their appearance, the boy leaving the hospital one month after admission, cured.

Remarks.—It is as difficult, if not impossible, in the description of a case, to give a correct impression of the symptoms in all their severity, as it is to render an accurate idea to its readers of the benefit of any treatment which was adopted. The case which I have just quoted, to my mind was a most admirable example of the benefit of bleeding and the antimonial treatment in injuries to the lung, and I wish that I could make as strong an impression upon my readers of the value of such a practice as the careful watching of this example made upon myself.

There was no doubt as to the extent of injury which had been inflicted; the passage of two tons' weight over a chest, followed by direct evidence of fracture of many ribs, copious hæmoptysis and collapse, were alone sufficient to indicate to the surgeon that some severe laceration of the lung had taken place. After the lapse of a few hours, that is, as soon as the collapsed condition had passed away and the circulation was restored, the marked dyspnœa and congestion of the veins, the rapid and hard pulse, together with other physical signs, too surely pointed to an excessive engorgement of the lungs, and that if relief was not afforded, absolute suffocation by the patient's own blood would speedily ensue. At such a crisis, antimony, however beneficial in simple cases, could not alone be trusted. There was no time for it to take effect

before the mechanical process of suffocation would have done its worst, and death must almost necessarily have followed.

Under such circumstances bleeding was performed, a free incision was made in the vein, and, as the blood flowed, life seemed gradually to return. The breathing, from being an act of labour, became quiet and subdued. The eye, from being deadened and congested, became bright and natural. The pulse, from being full and hard, became softer and less bounding; and the boy's feelings, equally valuable, from being impressed that death was nigh at hand, became more hopeful and resigned; and, as a spectator, I felt that such a hope was valid, and that success might crown our practice.

The relief which such a practice afforded at the onset was not to be despised when like symptoms returned; and the repetition of the bleeding was followed by a repetition of all its benefits. The antimony then came in to complete the cure; the blow had been struck by the double venesection; the pulmonary vessels had been relieved of their congestion, and the antimony had now succeeded in lowering the circulation, and had thus, by preventing such a repetition of the former threatening symptoms, perfected the cure.

These remarks, which I have been induced to make upon this case, and the practice which has been illustrated by it, have such a firm hold of my mind, from the careful watching of many similar instances to that just quoted, that I cannot recommend too strongly the general adoption of a like practice.

Bleeding, as an operation, is now one rarely performed; indeed, I believe that at Guy's Hospital it is rarer than any capital operation. In these cases of lacerated lung, however, when urgent dyspnoea makes its appearance, and the powers of the patient do not forbid it, I know of nothing which affords equal benefit, and which to the patient gives greater relief or to the practitioner greater pleasure. Bleed with no sparing hand; let the blood flow freely in a full stream, and as it flows the symptoms will gradually disappear. When relief has been obtained, immediately arrest the flow. Your aim has been to make an impression through the systemic circulation upon the pulmonary, and syncope can only do harm. Watch your patient carefully,

and repeat the operation if the symptoms should return, and, if necessary, repeat it a third time. I have never witnessed an instance where a third bleeding was ever required; at the same time it should be done if like symptoms make their appearance. The antimonial treatment, however, must not be neglected. The bleeding is really to relieve immediate symptoms, and to give time for the latter to take effect; when fully under its influence, the danger may be said to have disappeared, as few patients die from secondary inflammation of the lungs when once fairly under the influence of antimony.

I have no example to quote where such a result has taken place, and believe that, with judicious treatment, cases of fractured ribs and lacerated lungs, when not dying from the immediate result of the accident, seldom sink from secondary inflammation, if actively and boldly treated.

In the six fatal examples of such an injury, death followed at once or within a few hours of the accident; the laceration of the lung being so extensive that a fatal collapse ensued, and a speedy death; in such cases no hope can be entertained. But should reaction take place, and life be prolonged even for a short period, there is a hope, and the surgeon's aid is never more beneficially exemplified than when acting upon it with energy and decision.

SECTION 4.

On other cases of Injury to the Chest.

I will now proceed to quote an example of laceration of the lung, the result of an accident, but unassociated with any fracture of the ribs. As far as my experience goes, the case is a unique one, as I am unable to point out any work in which a similar instance is recorded.

CASE.—It took place in a boy, æt. 7 years, who, when playing in the road, was knocked down by the shaft of a cart; the wheel caught him by the left side of the lower part of his abdomen and turned him round, and stopped when just about to pass over the thorax.

Intense dyspnœa and severe hæmoptysis immediately resulted, and he was brought to Guy's. He was admitted

under the care of Mr. Birkett, and as I happened to be at the hospital I saw him. He was then in bed, lying on his right side, half turned over on to his abdomen, with his legs drawn up and flexed. There was intense dyspnoea and cough, accompanied with hæmoptysis. He was quite collapsed, and nearly unconscious; no indications of fractured ribs could be detected. He never rallied, dying two hours after the accident.

At the post-mortem the only external sign of injury was a bruise on the left side of the back. There was no fracture of the ribs, or any external indication of injury to the thorax. The right chest was filled with air and some ounces of blood, which evidently came from a laceration of the lower edge of the middle lobe of the right lung, about three inches long. The lung was partially collapsed. In the abdominal cavity were a few ounces of blood, from a laceration of the upper edge of the liver. There was also effused blood about the left kidney, from laceration of the supra-renal capsule.

Remarks.—This case is merely quoted to illustrate the fact that a laceration of the lung may take place independently of any fracture of the ribs. It is difficult to account for such an accident. As the patient was young, being only seven years of age, with ribs consequently more elastic, and the chest more capable of compression; it appears probable that the chest may have been so compressed, that the lung was dragged from its central attachment sufficiently to lacerate it. The interesting fact, however, remains, that there was no fracture, and yet a laceration—a point worthy of remembrance.

As a result of a severe contusion of the chest, mechanically interfering with the circulatory and respiratory functions, the following cases may be read with interest; the effects of the injury were directed upon the nervous system, congestion of the cerebral vessels evidently being the cause of the symptoms present.

CASE.—A man, æt. 23, an engineer, received a severe jam between the buffers of two engines on the anterior and posterior aspects of his chest. He was rendered completely

insensible, and bled profusely from the nose, blood also being extravasated into the eyelids and beneath the conjunctiva. In this condition he was admitted, about twenty minutes after the accident, with dilated pupils, and a slow, labouring pulse. In one hour he became conscious, and soon regained his natural manner; leaving the hospital well.

CASE.—The second case was in a healthy sawyer, æt. 26, who fell, when wrestling with a friend, with the whole weight of his antagonist upon his chest and abdomen. He was rendered by the accident completely insensible, and remained so about ten minutes, but when his consciousness returned he was totally unable to speak or to make any laryngeal sounds. On admission shortly afterwards, the skin of his head and neck were intensely congested, being of a bright colour. He was quite sensible, but dumb. Some fluid was administered, but it nearly choked him, evidently from paralysis of the muscles of deglutition as well as of the larynx. He was put to bed and rest was insisted upon; after eighteen hours' repose his speech suddenly returned and he could swallow with less difficulty; the congested appearance gradually disappearing. Two days, however, elapsed before his voice and powers of deglutition became as perfect as they were before the accident. The man left well.

Remarks.—There was little doubt by those who witnessed the condition of this man when first admitted, that intense congestion of the cerebral vessels was the most marked morbid condition which was present; the minute injection of the integument of the head and neck, with the vessels of the eye, rendering this fact apparent to the most casual examiner. The paralysis of the muscles of the larynx, associated with those of deglutition, indicated some affection of the pneumogastric nerves. The gradual disappearance of the congestion, and also subsidence of the paralytic symptoms, proved, that the mischief was but slight, and could be sufficiently accounted for by some temporary pressure; and it does not appear unfair to conclude that such symptoms were produced by the pressure of the venous blood returning from the head through the jugular vein upon the eighth pair of nerves, in some portion of its course, both passing through the foramen at the base

of the skull. The symptoms were those produced by local pressure, and as those symptoms disappeared when the pressure was removed and the natural circulation re-established, such an explanation appears to be the most probable. The case must be regarded as an interesting example of compression of the thorax, with its results, and being an uncommon one, is here quoted.

CHAPTER VII.

ON THE DISEASES AND INJURIES OF THE ORGANS OF CIRCULATION.

Independently of the dangers which immediately result from any injury to the circulatory organs, there is undoubtedly a natural dread of any accident or operation which may be accompanied with arterial hæmorrhage. It is impossible to calculate the influence which this fact has had, in bygone days, in retarding the progress of the surgical art; and even at the present time, very many members of the profession are still under its spell, and are apt to be unnerved and confused when this complication occurs in their practice. Nothing can better test the qualifications of a surgical practitioner than his conduct in such an emergency, and the scientific surgeon is at once recognised by his prompt decision and calm demeanour. His mind is not unsettled by the dangers and horrors of the scene; and his hand is alone rendered steady by the accuracy and certainty with which his acts may be directed. By vacillation many lives have been lost in the hour of extremity, and it is only by promptness of action that such an ending may be avoided.

We approach, then, the subject of this chapter already interested in the theme upon which it treats, and trust that the consideration of the material upon which our remarks will be based may not prove unfruitful, either in confirming such rules of practice as are generally advocated, or in leading our minds to know with certainty how to act in cases similar to those which have been brought before us.

On incised, punctured, and lacerated Wounds of Arteries.

The subject of wounds of arteries will first claim our attention, and a short analysis of the cases which have been admitted into Guy's Hospital during the last six or seven years will prove our starting-point.

I propose to analyse the materials before me in three divisions, dividing the cases into incised, punctured, and lacerated wounds.

Amongst the incised are eighteen cases of wounds of the radial artery, in some portion of its course ; three of the ulnar ; and two of the radial and ulnar combined.

There are five cases of wounds of the palmar arch ; one of the temporal artery ; one of the posterior tibial in the lower third of its course ; and one of the anastomotica magna.

In the wounds of the radial and ulnar arteries ; the application of a ligature to the divided ends was the practice adopted in twenty out of the twenty-three cases ; in the remaining three a pad firmly fixed on the wound, pressure, and elevation, proved sufficient.

In two examples pressure was employed in the first instance, but a ligature had subsequently to be applied.

CASE.—One was in a man, æt. 34, who received an incised wound above the wrist, from some machinery. Severe bleeding took place at the time, which was arrested by the application of a pad and pressure. On the tenth day, while scrubbing a table, he felt something give way, accompanied with a sharp pain ; copious hæmorrhage following, he came to Guy's. A double ligature was applied to the divided vessel, the lower ligature coming away on the third, and the upper on the sixth day ; convalescence following.

CASE.—The second was in a man, æt. 59, who received a blow from a knife, which divided the radial and ulnar arteries above the wrist. Pressure was applied at the time, arresting bleeding, but on the seventh day secondary hæmorrhage occurred. A tourniquet was put on, and the man sent to the hospital, with the arm much swollen. All pressure was removed, and the patient was placed in bed, with the arm raised.

On the third day, or tenth after the accident, bleeding returned; the wound was then reopened, and the divided extremities of the radial and ulnar arteries secured; in a few days the man left well.

Remarks.—These cases are sufficient to indicate that the practice, which is too frequently followed, of arresting hæmorrhage from a divided radial or ulnar artery by means of pressure, should never be employed when a ligature can be applied.

In two other examples the same result followed a like practice; and although in some instances pressure alone may succeed, it is not by any means a satisfactory treatment, and a ligature should be preferred.

In the wounds of the palmar arch the application of the same rule holds good when it can be carried out; but there are serious obstacles to such a practice, rendering it necessary that the majority of cases should be treated by other means. I have but one example before me where the vessel could be taken up and secured by a ligature; in three others, a ball or block of wood was securely fastened in the palm, with the fingers and hand flexed, and the whole arm elevated; all turned out successfully, but every surgeon must feel that such a practice is only a poor substitute for a more definite and correct one. Where the wound is a punctured one, pressure should be employed, as the palm of the hand is not a favorable spot for incisions or for finding arteries.

CASE.—A boy, æt. 16, having fallen off a horse, received a punctured wound in the palm of his left hand from the corner of a hoe; severe hæmorrhage resulted, and surgical advice was sought. A tourniquet was applied over the brachial artery, and a pad over the wound; this was kept on for two days, the tourniquet being occasionally slackened: when it was removed, the bleeding returned very copiously. He then came to Guy's Hospital, with the arm much swollen from the pressure of the tourniquet, and the dressings saturated with blood; everything was taken away, water dressing applied to the wound in the hand, and the whole arm well raised. On the fifth day after admission, or seventh after the accident, some hæmorrhage took

place, which, however, was checked by elevating the arm ; the day following, a slight return of bleeding making its appearance, a compress was applied over the wound, and the arm firmly fixed upon a splint. From this time everything progressed well, the wound healing, and the boy left cured.

Remarks.—This case is quoted as an illustration of the difficulties which a punctured wound of the palm may present to the surgeon, and also of the evils of a timid practice. The application of a tourniquet to the trunk of a divided vessel, although valuable when only applied for very temporary purposes, deserves the strongest censure when maintained for any lengthened period. In the example before us, the œdema and inflammation of the forearm were sufficient to show what might have been the result if the pressure, which had been kept on with but short intervals for two days, had not been removed ; and in the case of a man who divided his radial artery over the dorsum of the thumb, in which a tourniquet was applied and kept on for days, I well remember gangrene and amputation being the result.

Such instances are now fortunately becoming more rare, the case last mentioned took place thirteen years ago, having at its close been admitted under the care of the late Mr. Aston Key.

There is every reason to believe that a good ball or firm pad, well applied on the wounded vessel, with the fingers and hand flexed, and arm well raised to a nearly vertical position, would have proved quite sufficient in the case just quoted as the basis of these remarks ; and the bad effect, fortunately but temporary, of the pressure of a tourniquet, would not have been excited. The firm flexure of the forearm upon the arm in some cases will prove sufficient to arrest bleeding ; and when it can be tolerated such a practice is a valuable adjuvant ; but in several cases in which it has been attempted the patient has complained of so much pain as to render the position unbearable, and other means had to be adopted. Nevertheless it is a plan of treatment to be remembered, and applied when suitable.

The cases of wounds of the temporal artery, *anastomotica magna*, and posterior tibial, were treated by ligature.

The last case was in a man, aged eighteen, who received a wound behind the inner malleolus from an adze. Profuse hæmorrhage took place, and, when admitted, the posterior tibial artery was found to have been divided; a double ligature was applied, one to each end. On the twelfth day the silk came away, and cicatrization of the wound followed.

Amongst the cases of *punctured wounds of arteries* are two of the radial above the wrist; in both the artery was found to have been partially divided, and severe hæmorrhage resulted. A ligature was applied to the vessel above and below the wound, and recovery ensued.

Under the heading of punctured wounds of the femoral artery are three cases, all of which are worth recording.

CASE.—One was in a man, æt. 20, who received a stab, on November 23d, 1856, from a penknife, about the middle of the inner side of the right thigh. Some bleeding followed; but as the man immediately applied his finger to the orifice of the wound, it soon ceased, although he believed that he must have lost a pint of blood. The wound was then strapped up, and he kept his bed. On the 24th he got up and walked about for four hours. He called upon a surgeon, as he was in some pain, although the limb was not swollen, who recommended him to come to Guy's. On the 25th he remained all day in bed, as the thigh was painful and had begun to enlarge. On the 26th, or third day after the accident, he was admitted under the care of Mr. Cock. When examined, a small punctured wound was visible, situated about four inches below Poupart's ligament, over the Sartorius muscle; for about two inches round the wound the thigh was swollen, hard, and tense, but neither very tender to the touch nor pulsating; some pain existed, which was much increased upon moving the limb. The surface of the wound was dry, and free from any appearance of discharge. Rest was ordered to be enforced, and water dressing applied for three days; the pain gradually increased, and on the third day after admission, or sixth after the accident, there was a free discharge of a dark, sanious fluid, affording him instantaneous relief. On the tenth day, when using a bed-pan, profuse hæmorrhage took place from

the wound, evidently of an arterial character. A pad of lint and slight pressure, however, completely controlled it. The following day, being the eleventh, Mr. Cock determined to apply a ligature to the vessel, as there was no doubt as to the fact of its being wounded. Having divided the integument and fascia, and removed some large clots of blood which surrounded the artery, a small, vertical, punctured wound was at once seen; a ligature was applied above and below the wound, the leg was raised upon a pillow, wrapped in cotton wool, and the patient placed in bed. On the sixth day after the operation the upper ligature came away, and the lower on the eighth; some sloughing of the wound then appeared, which soon ceased on change of ward, and the man left the hospital cured.

CASE.—The second was in a boy, æt. 16, who, when employed cutting paper with a long amputating knife, allowed the point to jerk suddenly into his right groin, below Poupart's ligament. Profuse hæmorrhage immediately took place, followed by syncope. A tourniquet was applied, and the boy brought to Guy's Hospital. Admitted under the care of Mr. Birkett, on July 23d, 1858, a small, punctured wound was observed just below Poupart's ligament, over the course of the femoral artery. This was at once enlarged, and a ligature applied above and below an oblique wound in the vessel. No bad symptom appeared; on the fourteenth day the ligature came away, and a rapid convalescence followed.

Remarks.—The two cases which have just been briefly quoted are good examples of the symptoms which may be anticipated from a punctured wound of a large vessel, and are also useful in correctly illustrating the practice which should be adopted in like instances. In the second case, of the boy, where the wound was larger and the vessel more superficial, the immediate hæmorrhage was most severe, and if the accident had not taken place in the house of a medical man, who was well alive to the dangers of such a case and knew how to meet them, death would probably have at once ensued. Admitted within half an hour of the accident, there could have been no doubt as to the treatment which was required. To increase the wound in the integument, and ligature the

vessel above and below the seat of injury, was undoubtedly the line of treatment which was indicated, and the perfect success of the measure proved its wisdom. On the fourteenth day the ligature came away, followed by convalescence.

In the first case, the situation of the wound, and the immediate hæmorrhage following upon its infliction, would have led a surgeon at once to suspect that the femoral artery had been wounded; the immediate pressure applied through the patient's forethought, and the rest which was for the time preserved, were quite sufficient to allow the clot, which was necessarily formed around the vessel, to form a temporary plug, and thus prevent a return of bleeding; and perhaps if it had been wisely preserved, a cure might have taken place. The following day, however, the man got up, and it was not till after four hours' exercise that the clot previously formed had become disturbed, and the flow of blood allowed to recur. This second bleeding, accompanied with some pain, caused some alarm; surgical advice was sought, and he was recommended to come to Guy's. The bleeding, however, ceasing by itself, the pain not being very intense, and the local swelling but slight, he again believed that rest at home might prove sufficient; as the smallness of the wound, to the uneducated mind, could not be connected with anything like danger. For another day this rest was preserved, and no bleeding again appeared; but as the pain and swelling increased, he at last became alarmed, and was admitted into the hospital.

When admitted, there was no external indication of a wounded vessel. There was the evidence of a small puncture in the integuments, over the course of the femoral artery, but this puncture appeared cicatrizing; there was certainly some swelling from effusion beneath its seat; the vessels below were pulsating, but not at the seat of injury. The history of the case certainly indicated a wounded vessel, and it was believed that such was the real condition; however, it was thought advisable to see what nature would do, and to watch the case, keeping the leg well raised and in absolute repose.

For three days this treatment was carried out; the pain continued, and the swelling did not diminish; at the end of that period the wound again opened, and a quantity of decomposed and softened blood escaped; immediate relief was thus

given to the patient, the pain having been apparently caused by the tension excited by the effused blood; no hæmorrhage, however, followed. For another three days everything looked well; the pain had ceased, the discharge was lessening, and the general health was good. But it was clear that the wound in the vessel had not permanently closed, for the slight exertion produced by the use of the bed-pan proved sufficient to disturb the clot which had been formed, or rather to reopen the wound in the vessel made ten days previously, and a fresh hæmorrhage ensued.

Such an attack taking place under observation proved that nature alone in this case was not altogether capable of repairing the mischief which had been produced; surgical aid was imperatively demanded, and a double ligature was wisely applied, one above and a second below the punctured wound; no bad symptom following, a rapid cure ensued.

The wound in the vessel was observed to have been vertical, and this fact may in a measure explain the tendency to a natural cure, which evidently existed; and the doubt is still a natural one which suggests that a spontaneous cure might have resulted, if absolute repose from the first occurrence of the accident had been preserved.

That such cases do ever occur it is difficult to prove, as there is always room for doubt that the vessel had been really wounded. The following case, however, I believe to be an instance of such a recovery, and I will therefore briefly quote it.

CASE.—A boy, æt. 16, when quarrelling, received a punctured wound on the inner side of the middle of the thigh, from a chisel which was thrown at him; the injury was followed by profuse bleeding, which ceased when the boy became nearly faint. He returned home, and under medical advice kept at rest for two weeks; all appeared to go on well, no fresh hæmorrhage took place, and the wound was inclined to heal; there was some slight swelling, and the boy and his friends stated that “it beat.” At this period, or fourteen days after the accident, a renewed hæmorrhage appeared, the blood being stated to have come out in jets; it again ceased by slight

pressure, and for another week did not reappear; it then returned with equal force and in a like manner, ceasing also by the same treatment. The pulsation of the blood-vessel was much dwelt upon. Three days passed without bleeding, but as the boy's friends became anxious, they brought him to Guy's, where he was admitted under the care of Mr. Hilton. The wound was then open and granulating; it was situated over the femoral artery, in the middle of its course; the pulsation of the vessel was very feeble, none being detected at the seat of injury, but the tibials below were patent.

It was not thought right to do more than watch the case and to insist upon perfect rest, the limb being raised. This treatment was all that was required; the wound gradually healed, and no bleeding or other symptom appeared, the boy leaving the hospital, after a stay of two weeks, well.

Remarks.—The situation of the wound, and the frequent hæmorrhages in this case, appear to me alone to almost justify the opinion, that the femoral artery must have received an injury; the frequent and unsolicited evidence of the friends, that the bleeding pumped out in jets, and that the swelling about the wound "beat," tended much to confirm such an opinion, and I am still disposed, although after the lapse of some time, to regard the case in the same light as I did when I first saw it. It is difficult, indeed it is impossible, to prove, that this opinion is correct, but by all the rules of probability it appears justifiable.

The subject of lacerated wounds of arteries now claims our attention, the analysis of the incised and punctured wounds having been briefly considered. I have three examples, one of the axillary and two of the popliteal, associated with and caused by dislocation of the knee-joint.

CASE.—The case of ruptured axillary artery was in a boy æt. 8 years, who, when climbing, fell upon the spike of an iron railing, the point entering the axilla and causing a lacerated wound; some slight bleeding took place at the time of the accident, but not to any great extent, and he was brought to the hospital. When admitted, there was seen to be a lacerated wound in the axilla, over the course of the vessel; there was no

bleeding, and there was also a total absence of pulsation in any of the vessels. A pad was applied over the wound, and the arm kept at rest; no bad symptom followed, and after five weeks he left the hospital cured, pulsation in the radial having returned, but none in the brachial artery.

Remarks.—It is fair to believe, in the above case, that the axillary artery had been so injured as to become obstructed; whether it was completely ruptured is another question; the accident was followed by a gush of blood, which ceased, never to return, indicating a laceration of a vessel; and as the brachial artery was subsequently quite occluded, and as there was no evidence of any effusion or other cause to press upon the vessel and thus close it, it does not appear unreasonable to believe that the vessel had been torn across and had retracted into its sheath; it is well known that a lacerated wound, dividing an artery, even a large one, may take place unaccompanied with any bleeding, and in this instance such appears to have been the case.

I have seen a femoral artery torn across, and no hæmorrhage beyond the first gush ever took place, and in military practice such a result is by no means uncommon. The causes for this are now well understood, and need, therefore, no illustration.

CASE.—The following example of ruptured popliteal artery was produced by a compound dislocation of the knee-joint; it occurred in a man, æt. 32, who was admitted under the care of Mr. Poland; the tibia and fibula were dislocated forwards, and the popliteal artery was evidently ruptured; some extravasation was present about the part, but not to any great extent, and all pulsation in the vessels had disappeared. The accident was said to have been produced by the passage of a cart-wheel over the thigh. Primary amputation was performed, but the man never rallied, dying sixteen hours after the accident. Upon examining the limb, a wound was visible on the inner side of the knee-joint, through which projected the inner condyle of the femur, a small piece of which was fractured. The tibia and fibula were easily moveable forwards, and the head of the fibula was dislocated from the tibia. The crucial ligaments were

entire. The popliteal artery was torn across in its centre, the ends being from one to one inch and a half apart. Both extremities being well plugged; there was not much effused blood present.

CASE.—The second case was in a man, æt. 30, also admitted under the care of Mr. Poland. He was a cabman, and, when drunk, was said to have received a kick from a horse in the popliteal space. When admitted, the symptoms of lacerated artery were well marked, all pulsation of the vessels had ceased, and extensive extravasation of blood existed in the seat of injury. The integument and fascia were at once divided, and a ligature applied to each end of the ruptured vessel; gangrene, however, rapidly followed, and thirty-six hours after the operation amputation was performed; the man, however, never rallied, sinking forty hours after the amputation.

Upon examining the limb, the cause of all the mischief was quite clear; the whole of the ligaments of the knee-joint had been ruptured, the tibia and fibula having been dislocated forwards, the condyles of the femur having evidently, by their projection into the popliteal space, ruptured the vessel. The bones could be moved about in any direction, and the divided ends of the vessel were at least one and a half inch apart.

Remarks.—The two cases just quoted are good examples of such a rare and severe accident as rupture of the popliteal artery; but as both were complicated with complete or partial dislocation of the knee-joint, the dangers of the cases were much magnified. Both occurred in young men, and in both amputation had to be performed; and although success was not permitted, the practice I believe to have been correct.

When the vessel alone is ruptured and no other injury coexists, the application of a ligature to the vessel is the practice usually advised. But when other serious mischief, such as joint implication, coexists, amputation should be selected. It may be a question how far the former practice is correct, as the result of such cases are not encouraging, still it is the one generally advised and acted on, and I am not disposed to recommend a contrary practice. I have two other cases before

me of injuries to arteries, one of the femoral, the result of a gunshot wound, treated by ligatures, and followed by gangrene, tetanus, and death; and a second, of frequent hæmorrhage from the peroneal artery, the result of sloughing after a contused wound, treated by ligature, and convalescence; but as they are only in a collateral manner associated with the subject under discussion, I shall make no further mention of them.

Wounds of arteries having been considered in the chapter which has been just completed, the following case of *secondary subcutaneous hæmorrhage* may perhaps be quoted as an appendix; such instances are very rare, and indeed the following is the only one which has ever passed under my observation, and for its rarity alone is worthy of record.

CASE.—A man, æt. 19, received a severe kick on the outer side of his left thigh; but little swelling appeared at the time, and he continued at his work as a carman. For two weeks he continued his occupation, feeling somewhat stiff in the part, and at times complaining of some pain; at this date, when walking, he felt something suddenly give way, accompanied with a sharp pain, and rapidly followed by excessive swelling; in this condition he was admitted under the care of Mr. Birkett. On examination, the whole of the outer side of the left thigh was much enlarged, tense, and painful; the fluid, for such it appeared, was evidently beneath the fascia, although the skin was much discoloured, probably from the original injury. Hot and cold lotions were applied for twenty-four hours; but after the lapse of such a period, as pain continued, the part was tapped, and a quantity of black fluid blood drawn off; relief was at once afforded by the operation, and after several weeks stay in the hospital, the remaining effusion was absorbed, and the man left well.

There can be little doubt as to the nature of this case; the sensation of something giving way, followed by the rapid effusion of what proved to be blood, indicated the changes which had taken place; some vessel must have been injured at the time of the accident, which had subsequently ruptured, and had, by pouring out its contents, caused the secondary enlargement of the injured part.

CHAPTER VIII.

ON ANEURISM.

Although the subject of aneurism has been always one of intense interest, and for the last few years has been rendered more prominent by the improvements which have taken place in its treatment ; there is still vast room for greater strides before any very definite rules can be laid down, and before a surgeon can enter upon the treatment of a case with that absolute confidence which is so much to be desired.

. The clinical consideration of such cases as the experience of a large hospital has furnished me, requires, then, no apology ; as any material, if honestly given and correctly interpreted, must always be of use in furthering the great ends of all our practice—successful treatment. I have before me twenty examples of aneurism ; and amongst these there is one of the right common carotid, and one of the innominata, in neither of which was it deemed desirable surgically to interfere.

In the former case the right pupil was permanently and firmly contracted ; it was in an old soldier, aged fifty-seven, who had been the subject of rheumatism when in India, but who had otherwise enjoyed good health. He had accidentally discovered a pulsating tumour in the right neck fifteen months previously, and this had gradually enlarged ; it was situated in the lower portion of the common carotid, and caused little or no pain ; besides the local symptoms, the contraction of the right pupil was the only point of interest, probably from pressure on the sympathetic nerves.

There are fifteen instances of aneurism of the femoral artery in some portion of its course, two of these being in the upper portion, requiring the application of a ligature to the external iliac artery.

CASE.—The first was in a man, æt. 51, who had had rheumatic fever sixteen years previously ; the disease had been discovered only three months, and was situated just below Poupart's ligament. The external iliac artery was tied by Mr. Hilton. The ligature came away on the thirtieth day, and convalescence followed.

CASE.—The second was one of aneurism of the profunda femoris, at its separation from the femoral. It was in a young baker, æt. 26, who had never had rheumatism, and had lived temperately. The tumour had been accidentally discovered, four weeks previously, by a sharp pain in the groin, shooting downwards. He continued, however, at his work, but as the pain increased, he came to Guy's Hospital. A tumour was at once detected in the upper third of the thigh, in the course of the femoral artery; the pain the man experienced was very severe, leading Mr. Cock, under whose care he was admitted, to propose an immediate operation. The external iliac artery was accordingly tied, with complete relief. On the sixteenth day the ligature came away, on the thirty-first the wound had nearly healed, and the man's health had much improved.

Upon the forty-seventh day after the operation, and thirty-first after the removal of the ligature, a gush of blood took place from the small fistulous wound, which remained open; pressure, however easily arrested it, and no return took place. He rallied, and went on well for two weeks, when he began to complain of feeling ill and of pain in his chest; slight hæmoptysis appeared, and death nine weeks after the operation.

Upon careful dissection, the aneurism was found to have been situated at the origin of the profunda femoris; it was large, and free from clot. The secondary hæmorrhage had probably taken place from the lower part of the vessel, through a common trunk of the obturator and epigastric arteries (*vide* 'Path. Trans.,' vol. ix, p. 125). Death had evidently resulted from heart disease.

Remarks.—These two cases have been briefly quoted, as they are both of interest, the latter particularly so, from the profunda femoris being the seat of the disease. The application of a ligature to the external iliac was the only treatment which could have been employed, no room having been allowed for pressure above the aneurismal tumour. It is interesting to observe, that in the first case the ligature came away on the thirty-first and in the second on the sixteenth day.

The next two examples of aneurism were both in the left thigh, and were situated about Hunter's canal.

CASE.—One was in a man, æt. 30, who had by accident discovered the tumour three months previously; after a week's rest in bed, pressure was applied by means of the alternate application of a lead weight and screw tourniquet; so much pain and irritation, however, resulted from their application, that the treatment was abandoned, and a ligature applied to the vessel above the sac. On the tenth day the ligature came away; slight oozing of blood having taken place twenty-four hours previously; and convalescence followed.

CASE.—The second was in a man, æt. 38, who, a month prior to his admission, after experiencing pains in the leg, which he described as rheumatic, discovered an aneurism above Hunter's canal. Pressure was applied to the vessel in the groin, in the same way as in the previous case, and on the sixteenth day pulsation had ceased; in three weeks the tumour was quite hard and solid, and the man left cured.

Remarks.—The two examples just quoted were alike in all respects. Both were young men, in both the aneurism was of short duration, and about the same size, and in both it might have been expected that the same treatment would have resulted in a like end. In one, however, pressure proved quite intolerable, and had to be given up; in the second, a more fortunate result ensued. The reasons for this difference are at present not to be explained, but such differences are so frequent in practice, that few surgeons can expect that one definite line of practice will always succeed in all cases; rules, it is true, may be laid down; but they cannot always be carried out; our practice having to accommodate itself to the wants of each individual case. In the examples just quoted, although pressure failed to produce any beneficial influence, it did no harm; and as it might fairly have been expected to succeed, as in Case 2, the surgeon would not have been justified in at once resorting to the severer measure of operation before he had proved that the more simple one had failed.

Under the heading of popliteal aneurism are 11 cases, 10 in men, and one in a woman; 5 were in the left, 5 in the right leg, and one in both.

Their respective ages were—25, 27, 28, 31, 32, 36, 36, 37, 42, 56, 70, the majority being in early adult life.

Three of the cases were cured by pressure; five by ligature after pressure had failed. Two died from internal arterial disease when under treatment by pressure; and one died after amputation, from gangrene following the application of a ligature for a burst and diffused popliteal aneurism.

CASE.—In the case of a man, *æt.* 25, pressure had been applied seven months without any positive result; the application, however, of a pad and bandage over the sac itself, associated with the application of the clamp, in the end succeeded.

CASE.—A woman also, *æt.* 37, was treated by the clamp and weight for five weeks without any apparent advantage; a series of students then kindly undertook to keep up pressure with their fingers, and after sixty hours all pulsation ceased, and a recovery ensued.

CASE.—In the third case, of a man, *æt.* 27, pulsation ceased after the application of pressure for two weeks, and the tumour contracted and consolidated; but when he left, the vessel was still pervious, as pulsation existed in the vessels below, although there was none in the tumour.

Such a result was, however, most satisfactory; the aneurism, as such, had evidently consolidated, and was thus cured. The vessel was probably patent, as the arteries below freely pulsed. No return has up to the present been heard of, and a cure may confidently be asserted to have taken place.

Remarks.—The three cases just briefly quoted are good examples of the successful treatment by pressure, and also of the difficulties which are met with in practice. In one case (the first) a cure could not be obtained until the tumour itself was firmly bandaged, and the circulation through it thus retarded; in the second, manual pressure speedily succeeded although that produced by the use of instruments had entirely failed; in the third, a successful result followed the pressure by the tourniquet, although it was most probable that the vessel was still pervious, as indicated by the pulsation of the vessels below the tumour.

The five cases successfully treated by ligature, after pressure had failed, were as follows.

CASE.—One was in a man, æt. 32, admitted under my care in June, 1858, who had observed the tumour for five months. Pressure was applied, and carefully watched for some days, when the tumour had become firm and had apparently consolidated; the treatment was continued, as a precaution, for a few hours extra, when all the symptoms returned. The tumour became soft and pulsating, and, in spite of treatment, gradually enlarged; flexure of the leg upon the thigh, and thigh upon the pelvis was then employed, but after this position had been preserved for a few hours the pain became so intense as to be intolerable. The vessel was at length tied. On the twenty-fifth day the silk came away, and a recovery ensued.

Remarks.—In this case pressure at first appeared to have done all that could have been desired; the tumour rapidly consolidated and diminished in size. The students who had charge of the case, in their anxiety to preserve perfect pressure, I fear, manipulated the tumour too much in their examinations to detect whether they completely commanded the vessel; the fibrin, I believe, by these manipulations became disturbed, and its subsequent deposition was not permitted.

The perfect arrest of the circulation through the tumour by the double flexure of the leg and thigh was very marked, and led me to anticipate a most successful result. The intolerable pain which soon, however, appeared, put an end to all such hopes, and such treatment had to be abolished. A ligature fortunately subsequently succeeded, and a cure ensued.

The case is a valuable one in a practical point of view; it demonstrates to a great degree the value of pressure as a means of cure, for the tumour had nearly become consolidated, and it was only as a precautionary measure that the pressure was ordered to be kept up for a few extra hours; it proves, too truly, the evil results of anything like manipulations of the tumour when under treatment by pressure, as I could never divest my mind of the idea that it was by these manipulations that the treatment had proved abortive. It showed well that the double flexion of the leg and thigh had the complete

power of arresting the circulation through the vessel, and therefore give undoubted hopes (which recent experience has realised) that in other cases such a treatment might prove of value; and lastly, it proves that even when all these measures have failed, a recovery by ligature may fairly be anticipated, and that the delay, and interference of the surgeon, had by no means any deleterious influence on the ultimate result.

CASE.—The second case was in a man, æt. 36, admitted under the care of Mr. Birkett. He was an Irishman, and somewhat troublesome to manage. He had felt an aneurism for six weeks, preceded by pain for six months; it was large, soft, and protruded much on either side of the popliteal space.

Pressure was applied, but, from the man's stupidity, it could not be kept up without intermissions; and as the tumour was evidently enlarging, a ligature was applied; on the ninth day it came away, and recovery took place.

CASE.—The third example was in a man, æt. 36, also under the care of Mr. Birkett; he had discovered the swelling only three weeks, and had never had any pains or rheumatism. Pressure was applied for four weeks, with apparent benefit, when the tumour suddenly enlarged, and had, without doubt, given way. A ligature was at once applied; on the ninth day it came away, and convalescence ensued. A few weeks subsequently, on his complaining of pain in the opposite ham, a second aneurism was discovered. It was not deemed desirable to attempt the treatment by pressure, particularly as the man requested the application of a ligature. Accordingly the operation was performed. Upon the twenty-second day the ligature came away, and a cure resulted.

The interest of this case is the rupture of the aneurism whilst under treatment, and the double nature of the affection. Other comments upon it are unnecessary.

CASE.—The fourth case was of a man, æt. 42, admitted under the care of Mr. Birkett, with an aneurism in the right popliteal space; he was a labourer, and had enjoyed good health. The disease had been discovered only six weeks; the tumour

was very large, and somewhat firm. Pressure was applied after the man had been kept at rest for a few days, and maintained for one week, but without benefit; and as the aneurism showed a disposition to enlarge, and the irritation of the tourniquet, &c., became intolerable, a ligature was applied. Everything went on well; on the twenty-first day the ligature came away, and convalescence followed.

CASE.—The fifth case is still under treatment by Mr. Poland; it occurred in a man, æt. 31, who had been the subject of rheumatism for years. The tumour was in the right leg, and had been discovered only two months. Pressure was applied, as usual, and preserved for three days, when the integument inflamed, and caused so much pain, &c., that the vessel was tied. On the fifteenth day some secondary hæmorrhage took place, and was repeated on the seventeenth, when the wound was opened, and both ends of the vessel tied. On the twenty-second day the ligatures came away. The case is still under treatment.

Upon the whole, the analysis of the cases of popliteal aneurism treated by pressure is a tolerably satisfactory one. It is true that but three out of eight cases in which success might have been expected by such treatment have been recorded; in the remaining five the application of a ligature had subsequently to be resorted to; but in neither of these instances was there the slightest evidence to show that the pressure had done any harm; the cases went on well after the ligature had been applied, and no bad symptoms interfered with convalescence. If, then, no harm or evil result can be shown to have taken place from the simple practice of pressure; and as success in a certain number of cases may be expected; the propriety of attempting a cure by such means before resorting to a ligature cannot be doubted. At the same time the success of ligaturing an artery is very great, and it is hardly right for the surgeon to waste too long a period in his attempts to obtain a cure by pressure, when such a favorable line of practice as the application of a ligature can be carried out. But there is another argument in favour of pressure which cannot be overlooked, and that is, the beneficial tendency which it exerts in encouraging and establishing the collateral circulation in the limb; its influence

in this direction doubtless is very great, and should accordingly be weighed in the balance when a comparison is being made between the two forms of practice.

I should, then, suggest that in all cases of popliteal aneurism, unless any decided symptoms are present contra-indicating the treatment, pressure should be primarily resorted to; invariably carrying out the rule that the patient should preserve absolute rest, in the horizontal position, with the limb raised, for a few days previously. Let a few weeks, say a month, be expended on such a practice, and if good hopes are not held out or realised in that period, let a ligature be applied. Looking at the thing personally, the above is the line of practice I should select if I were the subject of aneurismal disease; and as such an argument is always of value, I should consequently recommend the same.

As to the period of time at which a ligature separates from the diseased vessel, no rule can be laid down; it will be seen, from the following analysis, to be very variable. In the cases before me, the time was, from the external iliac, thirty and sixteen days respectively; from the femoral, nine, nine, ten, twenty, twenty-one, twenty-two, and twenty-five days. Nine days is the earliest period, and thirty the latest; a very wide difference; fairly proving that no general rule can be laid down when the separation of the ligature may be expected.

CASE.—The first of the two cases proving fatal when under treatment was in an old man, æt. 70, in whose left popliteal region was an aneurism, the size of an egg, of a year's duration. Pressure was applied, but after a few hours, local gangrene appearing, it was discontinued. On the second day a fatal syncope destroyed life. After death the right ventricle was found gorged with blood and thin, the left contracted and empty; fibroid degeneration was present in the heart's structure, and the valves were covered with chalky deposits. The aorta was very healthy, the smaller vessels being diseased, the femoral remarkably so. The aneurism was very thin, and contained a soft clot. The vessels of the brain were also much diseased.

CASE.—The second was in a man, æt. 56, who had de-

tected an aneurism in his left leg for six months; he had been in a metropolitan hospital under treatment by pressure for six weeks without benefit; for one week he had been at home, resting the limb. When admitted, the whole leg was swollen and œdematous; the tumour was the size of a fist, and pulsated but very slightly. The leg was placed on a pillow, and rest enforced; on the second day the œdema of the limb had much subsided, and all pulsation had ceased; he complained, however, of some pain in his chest. On the seventh day the aneurism was but half its size, was quite solid, and the leg was natural. He appeared to be in good health, making no complaints, but in a few weeks he suddenly died. After death a large aneurism was detected at the origin of the descending aorta, which had burst and had thus caused death. The popliteal aneurism was about the size of a goose's egg; it was formed by a pouch from the anterior surface of the artery, the lower portion of the vessel passing over it when looked at from behind. Two-thirds of it was filled with fibrin, the remaining third with fluid blood, so that the cure was only progressing. The vessels were extensively diseased throughout the body.

The example of death from amputation for gangrene of the leg, following the application of a ligature to the femoral artery for a burst and diffused popliteal aneurism, took place six years ago, and deserves a short abstract in this place.

CASE.—It occurred in a farm-labourer, æt. 25, who three months previously discovered a pulsating tumour in his right popliteal space; his attention having been drawn to the spot by a pain shooting down the leg. He continued, however, at his work for one month, when he sought advice. He was directed to apply a poultice to the part, and as this gave no relief a puncture was made into it with a lancet; nothing, however, then escaped; but the following day, severe hæmorrhage coming on, he was sent up to Guy's with a tourniquet on the femoral artery. When admitted, under the care of Mr. T. Callaway, the whole of the popliteal region and leg were swollen from extravasated blood, and as the history of the case correctly revealed its true nature, a ligature was at once applied to the femoral artery; gangrene, however,

rapidly followed the operation, and on the twelfth day amputation was performed, and twelve days subsequently the man died exhausted.

On examining the limb after its amputation, an enormous, diffused aneurism was made out; the whole tissues of the leg and thigh were infiltrated with blood, and it appeared probable that this extravasation, by its pressure, had arrested the venous circulation of the limb, and had thus assisted the rapid development of gangrene.

Remarks.—The case is an instructive one in many ways; the error which his first adviser had committed in not recognising the nature of the case was a very grave one, although good men have fallen into it before, and the practice based upon this mistake was equally to be blamed. Carelessness must have been the fault, and not ignorance, for the symptoms, as told by the man, were so palpable, and most clearly indicated the true nature of the disease. To any student who may peruse these notes let the moral be deduced, that a correct treatment can only be based upon a correct diagnosis, and that if the latter is obscure, let greater caution be observed in carrying out any treatment which may suggest itself. To plunge a lancet into an aneurismal tumour is indeed a great error; the thought of such an accident excites a thrill of horror, and the fact that it has occurred should be a warning to the careless.

That gangrene should have followed the rupture of the aneurism and the application of a ligature to the diseased vessel is a point of interest, especially when associated with the cases previously related of rupture of the popliteal vessel; and leads one almost to doubt the wisdom of the practice which suggests the propriety of ligaturing the vessel in such cases, and to question whether an amputation is not the better practice. It is a point worthy of consideration, but not one to enter into in this place.

CASE.—One of the three examples of aneurism of the vessels of the forearm, was of the radial in the upper portion of its course, just where given off from the brachial artery. It was in an old woman, æt. 62, who had worked hard, and had six months previously, when wringing clothes, felt some-

thing give way at the part; the tumour soon appeared, and gradually increased to the size of a walnut. A pad and pressure were applied on the part, with the forearm flexed, for three weeks, but without benefit; the patient then left, on account of some family reasons, to return for operation; but in this we have been disappointed.

The two other cases were aneurisms of the radial and ulnar arteries after a punctured wound, treated by pressure.

CASE.—One was in a man, æt. 19, who, six weeks previously, had received a punctured wound from a splinter of iron in the lower third of the radial artery; the accident was followed by a jet of blood, which was checked by a compress and bandage. The wound healed readily, but a pulsating tumour rapidly appeared, which steadily increased. When in the hospital the aneurism suddenly gave way; the sac was consequently laid open, and the vessel tied above and below the punctured wound. On the sixth day the ligature came away, and a cure resulted, the radial artery pulsating when he left the hospital.

CASE. — The second was in a man, æt. 19, who, nine weeks previously, had received a punctured wound from a pipe over the right ulnar, below the wrist. Hæmorrhage came on, which was arrested by pressure; and when the wound had healed, one month prior to his admission, a pulsating tumour appeared, which gradually increased to the size of a walnut. The sac was laid bare by Mr. Poland, and the vessel ligatured above and below; the pulsation, however, was not commanded, in consequence of a third vessel supplying the sac from beneath, which could not be reached. The radial was then ligatured, as pressure upon it arrested pulsation, and a steady cure resulted.

Such cases as these, point out the error of treating the wounds of vessels by pressure alone. In the wounded superficial ulnar and radial arteries, it is not a difficult operation to apply a ligature, and it is certainly the safest; when, therefore, it can be done, it should not be deferred.

CHAPTER IX.

ON NÆVUS.

The interest connected with the subject of nævus is of a double character; the disease being, as a rule, congenital, there has always been a strong inclination, both on the part of the public and professional mind, to assign the development of such growths to the mental or emotional conditions of the maternal parent; and the theories thus framed by the superstitious portions of our nature have not been flattering to man's intellect. It is not my object to follow out this portion of the subject; it will suffice for me to give it as an opinion, that positive evidence is wanting to prove that there exists any connection between mental emotions on the part of the mother; and the development of growths described as nævi.

The pathology of this disease is another subject of great interest, and at present it is wrapped in some obscurity. That it is a disease of the capillary system there can be no doubt; that in some cases the arterial, and in others the venous system, has a predominating influence is also tolerably certain; and that the growth itself is allied to the natural erectile tissues appears equally probable; nevertheless, the exact anatomy of these nævi is not yet sufficiently intelligible, and it would well repay the investigation of any careful pathologist.

It is interesting pathologically to witness the growth and degeneration of these structures. A nævus, from being perhaps at first scarcely visible, may grow with variable degrees of rapidity to enormous dimensions; it may commence entirely in the skin, and, not involving the cellular tissue beneath, may begin and end as a purely cutaneous nævus; the ordinary port-wine nævi, and others of a like character, are, as a rule, of this description.

Others may originate in the cellular tissue beneath the integument, and if their development is not great, they may never involve the skin or other tissues, but may begin and end as the subcutaneous nævus. These may be known by

their peculiar feel; they will be soft and spongy, yet more or less fibrous and elastic. When the child cries, dilatation may be visible, and to the eye and to the fingers such an expansion may be perceptible; a few large veins may generally be observed beneath the integument, and by these signs it is not difficult to diagnose the disease under consideration.

There is a third or mixed variety, composed of the two former ones combined—that is, the *nævus* is both cutaneous and subcutaneous; originating, as a rule, in the subcutaneous tissue, and gradually involving the integument itself.

The distinction between these three classes of *nævi* is practically of great value, as the treatment must be modified according to each form.

In the purely cutaneous *nævus* alone are caustics of any value. Nitric acid, or potassa fusa, carefully and freely applied, in such cases are often sufficient to obtain a cure; but if the *nævus* involves the deeper subcutaneous tissues, it cannot be expected that any benefit will accrue from their application. The acid or caustic acts only upon the part to which it is applied, and as it can only be applied to the surface, it is only upon that that any influence can be exerted. As a consequence, it should be remembered, even in such a simple case as *nævus*, that a correct practice can only be based upon a correct diagnosis, and that if the diagnosis of this purely cutaneous *nævus* is mistaken, the practice based upon it is sure to fail.

In the simple and uncomplicated subcutaneous *nævus* the application of external remedies are palpably inexpedient; and it is in these that the value of the subcutaneous ligature, or of the injection of the perchloride of iron, is often most admirably illustrated. The former I regard as the most certain and most rapid method of cure; the treatment by injection is always uncertain, and not to be relied upon, although in exceptional instances it acts very favorably. It is a practice which I now rarely adopt, as I find that other treatment is more certain in its effects and more rapid.

When a subcutaneous *nævus* can be isolated, the subcutaneous ligature should be selected; and when this isolation cannot be carried out, the treatment by seton is

most valuable. A few threads passed through different portions of the growth, and left in for a few days (that is, sufficiently long to excite adhesive inflammation), will generally prove sufficient to destroy the nævus; the effused fibrin, by its subsequent contraction, strangulating the minute vessels, and thus allowing the degeneration of the vascular growth.

If one application of many setons fails to effect a cure, a second should be attempted, and a third or fourth should not prove discouraging. Perseverance will generally be followed by success; but a repetition of their application should not be carried out until the immediate effects of the former have passed away.

In the mixed or third variety of nævus, that is, where both the skin and subcutaneous tissue are involved, the application of ligatures to the whole, or excision, where it can be carried out, is the best treatment.

The form of ligature should be adapted to the size and situation of the nævus; it may be tied in one, two, three, or more portions; pins may be used, or otherwise, according to the fancy of the operator or necessities of the case; the object to be attained is thoroughly and completely to strangle the growth, and if this is done it is immaterial as to the means—efficiency is the only test.

When the nævus can be isolated, as in those forms which are completely pendulous, excision is the simplest and most efficient remedy; the base may be fixed by a clamp, and on its central side ligatures may be passed so as to include the whole of the base of the tumour; on its distal side excision may be performed. One clean incision being made along the side of the metallic clamp, the actual cautery may then be used to prevent all chance of hæmorrhage if any portion of the divided nævus should have been left, and the clamp may then be removed; the ligatures, as previously applied, will maintain the edges of the wound together, and a lineal cicatrix will alone remain. This practice has proved successful in many instances, and when it can be repeated it should be carried out.

In cases in which, from their position, or from their diffused nature, neither form of practice as just indicated can be

employed, the treatment by seton is most valuable. It is a practice which of late years has fallen somewhat into disrepute; why I know not, but from considerable experience in such a practice I can most conscientiously advise its reintroduction.

It must not, however, be forgotten that these *nævi* have a natural tendency to degenerate and to undergo a cure; their rapidity of development and situation should alone lead us to adopt any surgical treatment. If situated in any portion of the body where disfigurement is of no consequence, and the *nævus* shows no disposition to enlarge, it may with safety be left alone, for it is tolerably certain that as years advance it will degenerate and become a simple and harmless tumour.

The form of degeneration which they generally take on is very interesting; the vessels apparently contract and, at any rate, cease to grow; the cells of the erectile tissue, instead of being filled with blood, become closed, and, by the outpouring of a serous fluid, cysts are formed. This cystic form of degeneration is the only one with which I am acquainted, and it appears to be most characteristic of the *nævoid* structures.

The appearance of these degenerate tumours is very peculiar. In the purely subcutaneous form which has taken on this action, an incision into it will show fibre-tissue, and the dense bands will be divided by numbers of cysts, varying from the size of millet-seeds to marbles, or even larger; these may contain simple serum, or the serum may be stained with blood; in some cases the secretion will be more inspissated; fat may also be deposited within the meshes of the fibre-tissue, but this is accidental. The general appearances of the tumour are very characteristic, although it is not sufficiently recognised.

In the cutaneous and mixed form of *nævus* which has undergone degeneration, the difference in its position will of course cause some difference in its structure. The subcutaneous portion will present appearances like those which I have already described. The cutaneous will be modified by the anatomical peculiarity of the *intégument*; externally, a peculiar, warty tissue will present itself; if manipulated, how-

ever, these warty-looking growths will have a spongy and elastic feel, and if these are punctured, blood or serum will escape; if serum, a cyst developed in the cutis or true skin will have been opened; if blood escapes, the degeneration is going on, but is not perfected. The capillaries are not closed, and, as a consequence, blood flows through them into the cellular interspaces, and thus escapes. Nevertheless, the pathology is the same in both, the anatomical peculiarity of the part in which the growth has been developed being sufficient to explain the difference.

This subject is a tempting one to enlarge upon, but as my object is not to enter into pathological subjects, except in so far as such investigations are necessary to render the purely practical more intelligible and rational, I must forbear.

Amongst my notes of cases admitted into the hospital since September, 1853, I have forty-five examples. Amongst the out-door practice such cases are very numerous, but it is my wish to confine my statistics to such cases alone as were admitted.

There is only one case of the purely cutaneous nævus, which was developed on the forehead, and was covered with hair; it was destroyed by nitric acid, but when the child left there were indications of its return.

There are eighteen examples treated by the application of a ligature, and these were all of the mixed variety, the ligature including the integument and cellular tissue, with nævus growth beneath. Sixteen of them were in children less than two years of age. Two were in girls sixteen and twenty-four years of age, in whom the growth was increasing.

In one case only was the purely subcutaneous ligature employed, but it was followed by success.

In twelve cases of the subcutaneous or mixed varieties, the treatment by injection was carried out, the perchloride of iron having been used in all. In seven a successful result ensued, the nævus becoming indurated, and apparently in an inactive condition. In one case suppuration followed, but a cure appeared probable when the child left. And in four instances the whole tumour sloughed off, the inflammation excited by the injection having been too intense, and sloughing followed.

In five examples of pendulous *nævi*, excision was successfully performed by means of the clamp, ligature, and excision, as previously described; in each a linear cicatrix alone remained, and the impression left upon the surgeon's mind by the observation of these cases is so favorable, that a similar line of treatment, when practicable, cannot be too highly recommended.

In six cases the degenerate *nævus* has been excised. In three the degeneration was complete, the patients being four, twenty-five, and eighty years of age. In three, aged respectively twelve, thirty, and fifty-two, it was incomplete, but success resulted.

And in five cases no treatment was deemed advisable. On the whole, however, a successful prognosis may generally be given. In my own practice, based more particularly upon the out-patients, the treatment by setons has been extensively employed, and with most uniform success; indeed, in the cases which I have previously pointed out, I can most confidently recommend the practice as worthy of adoption; it is suitable to many cases where other treatment would be employed, and still more so where none other is even applicable.

Table of the Injuries and Diseases of the Nose, Larynx, Thorax, with its contents, and of the Organs of Circulation, admitted into Guy's Hospital from October 1st, 1853, to June 30th, 1860.

	Cured.	Relieved.	Died.	Total.
Polypus nasi .....	...	22	...	22
Pharyngeal polypi	1	5	...	6
Malformed septum .....	...	1	...	1
Chronic inflammation of the Schneiderian membrane .....	...	1	...	1
Ozæna .....	...	3	...	3
Foreign bodies in larynx.....	4	...	4	8
Œdema of glottis from boiling water	7	...	5	12
Diseased larynx .....	...	6	1	7
Superficial wounds of throat	21	...	1	22
Deep wounds of throat	7	...	7	14
Fractured ribs, simple	106	...	2	108
Fractured ribs and injury to lungs.....	21	...	6	27
Lacerated lung .....	...	...	1	1
Compression of thorax	5	...	...	5
Immersion	7	...	4	11
Wounds of chest	2	...	3	5
Wounds of arteries	37	...	2	39
Subcutaneous secondary hæmorrhage	1	...	...	1
Aneurism, cervical .....	...	2	...	2
Aneurism, femoral	11	...	4	15
Aneurism, humeral	2	1	...	3
Nævi.....	43	5	...	48
Wounds of veins	2	...	3	5
Ruptured varicose veins	5	...	...	5
Dry gangrene and gelatio	7	...	4	11
Epistaxis	12	...	...	12
Hæmorrhage from gums.....	6	...	...	6
Local phlebitis	24	...	...	24
Thrombus	8	...	...	8
	339	46	47	432

CATENA OF CASES
ILLUSTRATING
THE USE OF FORCEPS
IN
EXTRACTION OF CATARACT.

By JOHN F. FRANCE.

I AM induced to publish a further report of cases of cataract extracted with the aid of forceps, because the mode of proceeding is still novel, and proves, on extended trial, fully productive of the advantages which at the outset it seemed to confer. I will first relate concisely twenty-one cases thus operated on, chiefly during the season of 1859; and will then briefly collate their results with others detailed in this work in 1858, hoping thus to promote the wider adoption of a plan which I have found in my own practice a solid improvement. The essence of that improvement consists in the perfect command of the globe, obtained by simple means; so simple that, were not this character itself a substantial recommendation in any surgical appliance otherwise efficient, had not the object it accomplishes been long aimed at in vain, and were not the issue at stake of deep importance, I might justly feel diffident in drawing attention afresh to the subject.

It has heretofore been customary to control the motions of the eye, while the corneal section is in progress, by the regulated pressure of the fingers; but valuable as is the assistance thus rendered as far as it goes, it falls short of what could be desired in an ordinary case, and often quite fails to keep the

irritable, restless globe of a nervous patient even moderately quiet. Were proof of the correctness of this statement wanting, we should find it, on one hand, in the varied instruments which have been contrived with the view of ensuring that steadiness, on which accuracy in effecting the section must greatly depend; or (failing that object) with the purpose of making a safe section in spite of the opposite condition. I have, in my former paper,¹ made a brief historical résumé of these inventions; which have all, unhappily, in practice proved abortive, though numbering among their authors and patrons Benjamin Bell, Ware, Beranger of Bordeaux, Le Cat, Pellier, Guerin, Demours, Guthrie, Scott, &c. On the other hand, the careful rules laid down in the most approved modern treatises on ophthalmic surgery for enlarging an inadequate section of the cornea, and for avoiding injury to the iris when imminent, or treating it when inflicted, collaterally but strongly attest that the defect I have pointed out still exists at the present day.

The importance of fixing the eye effectually can hardly be exaggerated; for from the spasmodic or instinctive movements of the organ mainly arise the accidents, to which this operation is obnoxious. Thus, for example, is for the most part produced that imperceptible gaping of the unfinished section which permits premature escape of the aqueous humour, and, contingently thereon, entails displacement and, perhaps, wound of the iris. Thus, again, originates deficiency in the extent of the incision; which can be properly remedied only, and with risk, by the employment of the secondary knife or probe-bistoury. It is not, of course, disputed for a moment that this operation, performed in the ordinary way by competent surgeons, is, in the great majority of cases, successful in restoring sight. But still, as even in the best hands one or other of the casualties just adverted to will occasionally take place, and render more precarious, or less perfect (where it does not absolutely prevent) the favorable result; an unobjectionable means of obviating their chief cause is a great desideratum, and cannot but conduce materially to enhance the average of success.

Before proceeding with the detail of cases of extraction

¹ 'Guy's Hospital Reports,' 1858.

aided by forceps, I will in few words repeat my description of the mode of employing that instrument in the operation. A pair of toothed artery forceps should be selected for this purpose, the dentations of which close at the extreme point of the nibs; as, if the latter are rounded off, so that their teeth do not project and bite at the very point, the forceps is likely to take hold only of the loose conjunctiva. The patient (being recumbent), is first desired to look upwards, while the operator at his head depresses the lower lid. The open nibs of the forceps are then applied upon the exposed globe beneath the cornea, and made by slight pressure to scrape along the surface as they close; in order to seize, together with a fold of conjunctiva, the tissues beneath (including, if possible, a few fibres of the inferior rectus tendon), and convert the forceps into a firm handle to the eye. The instrument is now delivered to an assistant, resting his hand upon the cheek; while the operator proceeds to raise the upper lid, and apply his fore and middle fingers above and on the nasal side of the globe in the usual manner, thus consummating his command of it.

Should any inconvenient reflection from the surface of the eye, the natural conformation of the parts, or other circumstance, render an alteration in the exact position of the cornea desirable; this can now be effected at pleasure by a word to the assistant, who can gently draw it into, and then (the surgeon's fingers co-operating) retain it steadily in, the precise position that is required. Meanwhile the attachment of the forceps serves simultaneously to keep the lower lid depressed, and enables the contact of additional fingers to be dispensed with. All things being thus prepared, the knife can be deliberately inserted, carried in a uniform, undeviating course across the anterior chamber, and be brought out accurately at the nasal margin of the cornea. No irregular movements of the globe delay the commencement of the section; no spasmodic inversion, without previous warning, obscures its progress, and invests its completion with sudden difficulty and danger. But the cornea remains stationary and central, alike while the cutting instrument pierces its temporal margin, while it divides the texture continuously, and when again it emerges at the nasal edge.

As soon as the cornea is fairly transfixed by counter-punctuation, and a narrow isthmus alone remains for division; the knife itself holds the eye still, the iris lies safely behind the instrument, and the forceps must be detached at the same moment that the pressure of the fingers is withdrawn. The section is then completed, and the operation from this stage (which is, indeed, the turning point of the whole) proceeds in the ordinary manner.

With respect to the cases which follow, I may again mention that nearly in all of them atropine was used; the patient was placed recumbent, and the upper section was made with Beer's knife in all; and, standing at the patient's head, I operated with the right or left hand, on the right or left eye, respectively.

CASE XXI.—Forceps-extraction; cure.

Mr. S—, æt. 65, a gentleman from Witham, in Essex, in the main healthy, though suffering occasionally from cerebral congestion, came to consult me in March, 1859. Cataract existed in both eyes; that in the left, of three years' duration, and hard; that in the right, softer and more bulky, pushing the iris forward, and developed only within the last few weeks, since the old man had remarried. He took lodgings near me, and on May 2d I extracted the left cataract, employing forceps as above described. The instrument gave steadiness to the globe, the section was ample, and the entire operation passed off satisfactorily. The flap at first turned down when the lid was allowed to drop, but was easily replaced, and, with the iris, lay in right position before the strips of plaster were applied. He made a good convalescence, and on the 26th of the same month returned into the country, having the cornea soundly healed, the pupil clear, central, and free, and vision excellent. It so remained in March of the present year.

CASE XXII.—Forceps-extraction in anæmic patient; threatening syncope; cure.

William N—, æt. 59, a coach-sawyer of St. Pancras—a pallid, unhealthy-looking, puffy-complexioned man, with the

edge of his pupils white from absence of their usual border of pigment—was admitted into Guy's in May, having hard cataract in the left eye of six months' duration. The right eye was unaffected. After six weeks of generous diet and steel medicine, I ventured on June 15th to extract. The eye was kept quite still by the forceps; a good flap was made, without casualty of any kind; and the cataract came forth spontaneously on opening the capsule, leaving a little, soft débris in front of the iris, which gentle pressure with the curette was employed to remove. The pupil became well contracted, and the flap lay in apposition before the plasters were put on.

While I was operating on another patient, an alarm was given that this man (who had been placed in a chair by his bedside) was fainting. The recumbent posture and a little wine soon restored him, and happily no disturbance of the eye was produced by the occurrence. On the 20th the flap was adherent, the anterior chamber replenished, and the cornea clear; but the pupil was covered by a film of whitish cortex, and vision was consequently impeded. On July 16th this film had disappeared by solution; and the anterior chamber being bright, the pupil central and clear, and vision good, he was presented.

CASE XXIII.—*Irritable globe ; forceps-extraction ; cure.*

Elizabeth Y—, æt. 63, a hale widow, residing in Bermondsey, with cataract in both eyes, had the left lens removed by me on May 25th. But for the forceps, the mobility of the globe would apparently have occasioned much difficulty; with their aid, however, a good flap was at once formed by Beer's knife. The cataract rose gently after the use of the curette; and upon its escape, the flap lay well in position, but the pupil appeared drawn towards the wound. The iris was therefore stroked back by the blunt extremity of the curette; and the eye being then exposed to light, the pupil readily became circular and central. The section had adhered by the fourth day; no unfavorable circumstance arose, and on June 17th the patient was presented with excellent vision.

CASE XXIV.—*Forceps-extraction ; rheumatic iritis ; cure.*
Subsequent loss of sight from independent cause.

Esther B—, æt. 45, a nurse, tall, pallid, feeble, and of anxious temperament, had cataract on both sides, consisting of firm nuclei invested in an abundant soft cortex; the right most advanced. Keratonyxis performed in February not having produced any material effect, on March 30th I extracted the right cataract. The eye was held quite steady with forceps, and a good flap formed without casualty; immediately on the completion of which (the capsule being already open) the cataract emerged. Some of the softer peripheral portion, which remained, was then removed from the front of the iris with the curette; the pupil contracted moderately on exposure to the light, and the flap lay *in situ*. The section healed well in the usual time; but on the 9th of April an attack of rheumatic iritis, accompanied with much circum-orbital neuralgia, and an effusion of blood collecting at the angle of the anterior chamber, supervened. After some trouble, the unfavorable symptoms were subdued; and the patient returned into the country, convalescent, in May. The cornea was then clear, the pupil central, unobstructed, and responsive to light; vision was excellent for ordinary purposes, and enabling her to read the text of an octavo volume fluently.

In July she returned to the hospital for operation on the other eye, seeing to read well with the operated one, which then continued quite sound. Unhappily, exposing herself imprudently, she caught an attack of acute general inflammation in the latter, which eventually terminated in extinction of sight.

CASE XXV.—*Forceps-extraction in intemperate patient ; partial recovery, but eventual loss of vision from arthritic ophthalmia.*

John J—, æt. 54, a hale-looking seafaring man, underwent extraction in October, 1858. There was considerable spasm of the orbicularis; but the globe was held steady, until counter-puncturation had been effected; it was then released from the

forceps, and a good section completed. The curette was not required, the capsule having been previously opened by keratonyxis: the cataract emerged satisfactorily on gentle pressure, and the pupil was left clear, round, and central, and the flap *in situ*, on applying the plasters.

The man's subsequent progress, however, was unfavorable. First there were threatenings of suppuration of the cornea, with serous chemosis and œdema; which led to closer inquiry than before as to his previous habits, and to the admission that he was accustomed to take a half-pint of gin daily, and sometimes three times that quantity, besides other stimulus. The apprehended mischief was therefore combated by generous diet, and a liberal allowance of spirit and porter; with the effect of averting the immediate danger, and procuring sound union of the corneal wound. But unhealthy quasi-arthritic inflammation of the iris and lining of the anterior chamber, accompanied by severe neuralgia, kept anxiety awake; and, though relieved by the treatment adopted, and especially by guaiacum, led to adhesion of the pupil to a disc of lymph occupying its area. He, nevertheless, convalesced so far, that on quitting Guy's in December, the cornea was clear, the cicatrix linear and crescentic, the pupil circular and central, and the lymph which occupied it attenuated to a thin film. Through this, fair vision for ordinary purposes was enjoyed; and he left the hospital of his own accord, to assume the skippership of a sea-going barge. As might be expected, the exigencies of this duty, and the return to his wonted habits, were ere long followed by recurrent inflammation, increased opacity in the pupil, and eventual loss of vision.

CASE XXVI.—*Abnormal prominence of globes; forceps-extraction; cure.*

Mrs. M. J—, of Streatham, aged about sixty-two, an obese person, with congested face, and exceedingly prominent as well as large globes, and long palpebral apertures, had double hard cataract, the right one complete. From the peculiar conformation of the eyes, there seemed little prospect of avoiding escape of vitreous humour; and I accordingly forewarned my assistant of this anticipation, which proved correct. On ap-

plying the forceps a good deal of spasm arose, which again subsided ; and the section was accomplished steadily and accurately, the forceps being of course disengaged before its completion. No sooner, however, had the knife divided the last band of cornea, than a gush of vitreous took place, carrying with it the cataract. The amount lost was so considerable, that the globe sank perceptibly, and the corneal flap turned down. After a pause, I succeeded in replacing the flap ; which, on closing the lid, continued concave from the loss of tension in the globe : the pupil (though the iris had not been wounded) was, as usual in such cases, horizontally oblong ; its upper edge, however, not being entangled in the section. The lips of the wound were adherent on the third day ; a smart attack of conjunctivitis, with abundant mucous secretion, afterwards occasioned some anxiety ; a fine membranous film, partially obstructing the pupil, at a later period required the use of the needle ; but by the 29th of August, the date of my last note, this lady was quite convalescent. Good vision for every ordinary purpose was re-established ; and, having before the occurrence of cataract been extremely short-sighted, she was now able to do needlework, and had read a chapter in the Bible, with the operated eye, without a glass.

CASE XXVII.—*Extraction of right cataract seven years before ; forceps-extraction of left ; cure.*

John H—, æt. 72, a cheerful and hale man, was admitted in May, 1859. I had extracted a cataract from his right eye in April, 1852 ; he had worked at his business in an iron-merchant's yard ever since, and still retained good vision (so as to read well) with it ; the pupil remaining clear, round, and free.

A cough from which he was suffering on admission having been allayed, I removed the left lens ; the forceps fixed the globe satisfactorily ; a good flap was at once completed ; and a large, dark-coloured cataract was then extracted in the usual way. The pupil on exposure resumed its circular form and central position, and the flap lay accurately in place. The cornea was adherent when inspected on the fourth day, and an excellent recovery ensued. He was presented on July 16th,

being able to read with the newly operated eye, and to see for all other ordinary purposes well.

CASE XXVIII.—*Forceps-extraction in cachectic patient ; sinking and recovery of cataract ; suppuration of cornea.*

A decrepid old man, who reported himself 67, but looked 76 years of age, was received from the workhouse in July, 1859, suffering from senile entropion and cataract. The former I remedied by operation; and then, at his earnest desire (though with much misgiving), after a month's course of generous diet, proceeded to remove the cataract. The globe was held steady by forceps, and a good flap formed at once without difficulty or apparent casualty. Nevertheless, on reopening the eye to introduce the curette, the vitreous was found exuding in considerable quantity. I then endeavoured to impale the lens from behind on the point of the curette, but ineffectually; the body rolled freely in the fluid vitreous, and then sank out of sight. On closing the eye, it again rose behind the pupil; and now by dint of slight pressure, in spite of the continuous oozing of vitreous, I succeeded in expelling the cataract,—very dark-coloured, hard, and smooth. A few red particles appeared in the anterior chamber; but the globe was not noticeably sunken, the iris was *in situ*, the pupil circular though not contracted, and the flap fairly replaced, ere the lids were closed. I had, previously to operating, explained to this poor fellow how very precarious were the chances in his case; and the result bore out the anticipation too faithfully. Disintegration of the hyaloid membrane (not undue pressure) had occasioned the loss of vitreous humour in the first instance; and subsequent melting away of the cornea by suppuration, without an attempt at healing, did but exemplify anew that defect of reparative power, which has become notorious in workhouse patients.

CASE XXIX.—*Forceps extraction ; impalement of cataract ; cure.*

Matthew W—, æt. 69, from one of the hospital estates at Long Sutton, in Lincolnshire, a tall, spare, moderately healthy

man, with apparently healthy eyes, except for the presence of double cataract and arcus senilis, was received into Guy's in June, 1859. The cataracts had been forming for three years, and been complete about six months. On June 15th the forceps were applied to the left eye, and an adequate flap was made at once without injury to the iris. Upon exerting the usual pressure after withdrawing the curette, the vitreous humour presented above the edge of the lens, bulged in the wound, and a small portion escaped. The eye was closed directly; a pause of a few moments was allowed; and then (as on again raising the lid, the cataract betrayed a disposition rather to sink behind the iris than to advance) I impaled it from behind with the curette, and brought it forth without further difficulty. The quantity of vitreous lost was inconsiderable; but the pupil of course became drawn towards the wound, and the flap was prevented lying in perfect adjustment. However, the continuous support of the lid, carefully plastered, counteracted any material ill effect from this circumstance; for on the 20th the section was adherent, the anterior chamber replenished, the degree of inflammation not in excess, and the vision satisfactory. Convalescence was progressive, though retarded for awhile by a quasi-vesicular elevation towards the temporal extremity of the wound, from yielding of the cicatrix. This gradually flattened down; and on July 18th the cornea was firmly healed, the pupil clear, but irregular from extension upwards, and sight good. He called on me afterwards to get an order for spectacles, having the eye strong, enjoying good vision, and full of gratitude.

CASE XXX.—*Cataract complicated with granular conjunctiva, and synechia posterior; forceps-extraction; cure.*

A. B—, a stout woman, of about 60 or 65 years of age, had presented herself for operation in 1858, but been remanded till the succeeding year, on account of the granular condition of the conjunctiva; which, though comparatively slight, was intractable. Fearing an ill result from ordinary extraction under these circumstances, I twice performed keratonyxis on the left eye, with the hope of diminishing the bulk of the lens; but the only apparent effect was the unfavorable

one of causing adhesions between the pupillary margin and the capsule. Hence, when, on August 3d, I determined to run the risk of extraction, and had atropine applied for the purpose; the pupil became expanded to a moderate degree, but very irregular from connecting filaments at several points,—a condition promising badly for the facile execution of the operation. The globe, which proved very irritable, was held sufficiently steady with forceps for the completion of an ample section; but great difficulty was experienced in effectually using the curette.

In most instances the eye spontaneously becomes tranquil after the corneal section is made, and tension has ceased from the outflow of the aqueous humour; in most cases, too, in which keratonyxis has opened the capsule previously, the curette is superfluous, and the lens is dislodged immediately the knife has cut itself out. But the present example differed from the rule in both respects; extreme irritability remained, while the twice-lacerated capsule had so firmly healed, that its reopening was indispensable. This was accomplished on the second attempt, and the cataract, though still sluggish in rising from its matrix, was disengaged by gentle pressure. Notwithstanding the previous operations, it proved of the full ordinary size, and dark coloured. No injury was sustained by the iris, nor did any vitreous escape; the flap lay well in apposition, and the pupil was fairly contracted before the plasters were put on.

Pain ensued in the afternoon of the operation (probably from the stretching of the adherent iris), but it soon subsided; and adhesion of the wound, sufficient to retain the aqueous humour, had taken place on the third day. After this, some trouble arose from prolapse of the iris; but the protrusion, being once punctured, subsided kindly. Superficial inflammation and pain accompanied this formation; yet the pupil continued clear, and the vision satisfactory. In October the patient was convalescent, the cicatrix being firm and even; and good vision (to read, &c.) was re-established.

CASE XXXI.—*Double cataract ; forceps-extraction ; cure.*

Elizabeth P—, æt. 50, was admitted, in June, 1859, with cataract, on both sides, of six months' standing, that of the left eye being most advanced. She was a stout, fair-complexioned woman, of rather indifferent health, and subject to gall-stones. On June 29th, I operated on the left eye. The forceps were affixed a little on the nasal side, instead of directly beneath the centre of the cornea ; and, consequently, did not keep the lower lid quite so well depressed as usual. They, however, held the globe steady, and an adequate section was made at once. No untoward accident occurred, and after use of the curette the lens came out favorably. The eye required exposure to the light two or three times, stroking through the lid, and introduction of the spoon of the curette, to replace the iris. The membrane was thus restored to good position, the pupil contracted, and the flap lay duly adjusted. The case did perfectly well ; and on July 13th the cornea was soundly healed, the pupil circular, central, and clear, and vision excellent. It continues so at the present time (June, 1860).

CASE XXXII. —*Forceps-extraction ; patient insubordinate ; arthritic iritis ; atresia iridis ; removal of false membrane ; cure.*

David E—, a Welshman, æt. 62, was operated on, June 29th, 1859. He proved nervous and excitable when on the table, contracting his orbicularis violently. Without forceps there would probably have been extreme difficulty in accomplishing the section properly ; with their aid, however, I formed a good flap at once. The curette was introduced a second time to divide the capsule, as the cataract was sluggish in moving ; a large and hard one then emerged satisfactorily. A bubble of air made its way into the anterior chamber, when the flap was raised by the curette ; and remained as a minute globule, even after the expulsion of the cataract—an occurrence very frequent in operations on the dead body, but not so in the living. As this was not extricated readily, while the flap and

iris had resumed their position, and the pupil was contracted, it was suffered to remain. An hour afterwards the bubble had disappeared, having probably been washed away by the aqueous humour, after the patient was placed erect in his chair.

The troublesomeness of which this man had given an earnest at the time of operation, was subsequently carried to an extent, which threatened to be fatal. He refused, in spite of repeated warning, to be confined to bed; to abstain, when there, from lying on the operated side; to keep the eye continuously closed, &c. The natural consequences of such conduct ensued; and, although the cornea healed well, a severe attack of catarrho-rheumatic ophthalmia, involving the iris, arose, and was at its height a fortnight after the operation. On July 23d the cornea was clear, the cicatrix semicircular and scarcely perceptible, the pupil central and perfect in form; but arthritic inflammation still continued, the iridal aperture was entirely blocked by inflammatory exudation, and vision of shadows alone remained. The inflammation at length subsided; and in November the man was readmitted, presenting simply the sequelæ of iritis, in a pupil contracted and closed by false membrane. With a fine needle, introduced through the cornea, I detached this, and stretched open the pupil, when vision of large objects was immediately re-established. He had learned a lesson of docility, submitted properly this time to the subsequent treatment, and a fortnight afterwards again left the hospital, with good vision and able to read an ordinary type.

CASE XXXIII. — *Forceps-extraction; hæmorrhage from wound of the iris; cure.*

Rebecca B—, æt. 56, a person in good health, had the right eye operated on, July 13th, 1859. The forceps held the globe quite steady, and an ample section of the cornea was made; but the iris was wounded close to the ciliary margin on the nasal side. The anterior chamber quickly filled with blood, which, in spite of cold sponging, accumulated again after evacuation, and quite hid the pupil from view. I was compelled, therefore, to open the capsule without seeing this aperture, by cautiously directing the curette to the centre.

This endeavour succeeded; and then, on gentle pressure, the cataract quietly emerged, clearing out the blood from the chamber as it advanced. Happily, no further hæmorrhage took place; but the flap lying accurately adjusted, the iris was visible in good position, with the pupil central and contracted, before the plasters were applied.

Five days later the flap was found adherent, but the anterior chamber not fully replenished; the pupil appeared circular, partly clear, partly occupied by a pellicle of soft cortex detached *in transitu*; the small false pupil, formed by the wound of the iris, could no longer be distinguished; the inflammation was moderate, there was no pain; and the degree of vision was satisfactory. A trace of blood was just perceptible within the chamber. After another interval of five days the cornea was clear, the anterior chamber free from red particles, full and bright; a fragment of lens still occupied a portion of the pupil, which had become elongated upwards, from the cicatrix yielding and permitting the iris to protrude. She left the hospital, of her own accord, on the 30th, with good vision; the prolapse, however (which she would not allow to be touched), yet remaining. She subsequently altered her mind, suffered me to remove the projection with Maunoir's scissors, and made, without further interruption, a good recovery. The cicatrix became consolidated without bulging or prominence; the pupil cleared, by the solution of the fragment which had partly obscured it; and she regained good sight for ordinary purposes, and, with a suitable glass, was able to read.

CASE XXXIV.—*Forceps-extraction in feeble woman with trichiasis; cure.*

Sarah C—, æt. 60, a debilitated subject, who, besides double cataract, had slight trichiasis and epiphora, was operated on by me, July 13th, 1859. By forceps the left globe was kept quite still, a good flap was made, and every step of the operation was accomplished without drawback; but the cornea was so thin and inelastic, that it fell into wrinkles after the removal of the lens. The pupil, however, contracted on exposure to the light, was central and circular, and the flap *in situ*, before the

eye was closed. She made an undeviatingly good convalescence, and was presented within three weeks, enjoying excellent vision, having the corneal wound well healed, and a central, round, clear pupil.

CASE XXXV.—*Forceps-extraction ; wound of iris ; impalement of cataract ; cure.*

Charles G—, æt. 65, a waiter and lamplighter at Greenwich, was admitted in October. Cataract was fully formed in the right eye, incipient in the left. On October 19th the forceps were employed to fix the globe, and an ample section of the cornea was made. Before its completion a jet of aqueous humour spirted out, and a portion of iris, advancing in front of the knife, was removed. A small quantity of vitreous now escaped, and more on reopening the lids ; I succeeded, however, in withdrawing the cataract at the first attempt, on the point of the curette. The flap of cornea then turned down (showing the attenuation of that texture in common with the hyaloid), but was quickly replaced, and the lids were carefully strapped. The man proved a tranquil, hopeful subject ; and, notwithstanding the untoward incidents of the operation, did well. In the course of his recovery a slight attack of iritis with nocturnal neuralgia supervened ; but by the 19th of November this had yielded, the cornea and pupil were clear, and though the latter extended up to the cicatrix, the sight for ordinary purposes was good, and he could read the second type on the diet-card. The cicatrix itself was sound, level, and crescentic. He retains excellent vision at the present time (June, 1860) with the right eye, and has now regained the sight of the left also, from which I extracted the cataract this season, employing forceps as usual.

CASE XXXVI.—*Forceps-extraction ; cure.*

Catharine M—, æt. 64. During my absence from town in September, Mr. Poland kindly undertook my duty, and extracted the cataract from this woman in Guy's. She proved difficult to control when on the table ; and, though the globe

was steadied with forceps, a bit of iris becoming involved in the incision was removed, and an escape of vitreous took place. The pupil was thus extended upwards, but no other ill result ensued, and the patient was discharged convalescent, and with good sight restored, in October.

CASE XXXVII.—*Forceps-extraction ; cure.*

Keziah P—, æt. 68, residing at Newington Causeway, was admitted into Guy's in June, 1859. She had cataract on both sides, and strongly marked arcus senilis; the globes were difficult of access from prominence of the brows, and deficiency of fat in the orbit. I operated on June 15th. The left globe was held with forceps, but from unusual laxity of the conjunctiva and submucous tissues, or an insufficient grasp of the latter, proved less under command than is in general the case, until the cornea was punctured. A good section was made, and the operation finished quite satisfactorily. The pupil contracted duly on exposure, and the flap was in apposition, before the eyes were finally closed. A pellet of cortex, peeled off in the cataract's transit, created a little temporary uneasiness a few days after the operation ; but this dissolved, convalescence progressed favorably, and on July 13th the patient was presented. The cornea was then healed, the pupil circular and central, at its upper part a still shrinking relic of the pellet above mentioned was perceptible, the rest of the pupillary area was quite clear, and excellent vision (to read, &c.) was restored.

CASE XXXVIII.—*Forceps-extraction ; cure.*

Joseph D—, æt. 61, a native of Liverpool, and lately an inhabitant of Guildford, by occupation a coach-smith, was admitted in 1859. He had cataract of ten months' duration in the right eye only. On May 11th, the globe being held with forceps, I effected a good section without casualty. The cataract emerged gently after the use of the curette, and a soft portion which had become detached was then removed. On exposure of the eye the pupil contracted ; and the flap lying in accurate position, the lids were closed in the usual way.

May 20th.—The cornea had healed some days; nor had an unfavorable symptom arisen until the last few hours, when he had experienced intermitting pain, with a good deal of conjunctival vascularity; the tongue was coated and white.

These symptoms were prescribed for; he again did well, and on June 17th was convalescent; the cornea being firmly cicatrized and clear, the pupil round, central, free, and unobstructed, and vision excellent for ordinary purposes and reading.

CASE XXXIX.—*Forceps-extraction; cure.*

Thomas T—, æt. 74, a grocer of Petworth, was admitted with cataract in both eyes of eighteen months' duration, in 1859; he was a hale, spare, dark-complexioned man. The right cataract being that most advanced, was selected for removal; and the eye (a well-formed one) was drawn into, and held steady in, position by forceps. The section was completed at once without casualty, and the operation concluded in every respect satisfactorily. The pupil became well contracted, and the flap in perfect adjustment. The operation was performed on May 11th; the cornea had adhered on the fourth day; and on June 11th he was convalescent, the pupil being circular, central, and clear, the cornea sound, and vision good. He was presented on the 18th, seeing excellently for all ordinary purposes, and able to read with fluency. [He has since recovered the sight of the left eye also, from which I retracted the cataract in July of the present year, using forceps as before.]

CASE XL.—*Forceps-extraction; cure.*

Patrick C—, æt. 74, a moderately hale labouring man, with well-formed eyes, and a cataract in the left only, of two years' duration, was admitted into Guy's on 25th April, and operated on on May 9th of the current year. The pupil was opened to a limited degree by atropine, and the globe commanded efficiently by forceps. The corneal section was enlarged by the bistoury, and the capsule lacerated a second time with the curette, as the cataract was sluggish in moving from its fossa. It then

slowly rose, and emerged; one cause at least of its previous inertia becoming apparent in the unusual size and firmness of the body. The stretched pupil did not fully contract, in spite of exposure to the light; and I had occasion to reduce a nascent prolapse with the spoon of the curette. The iris then appeared to lie in fair position, unwounded; and no vitreous escape took place. The cornea adhered readily; the tendency to prolapse of the iris did not recur; no bad symptom arose during his confinement; and on June 2d, being anxious to go home, he was discharged, having the cornea bright and clear, the pupil central and circular, and vision good. He was subsequently supplied with spectacles, and enabled to read with the operated eye.

CASE XLI.—*Forceps-extraction; cure.*

Sarah B—, æt. 52, a pallid, rather feeble person, had cataract in both eyes, in April, 1860. The anterior chambers were rather shallow, and the globes deep. On May 9th I extracted the right cataract, having had the pupil dilated by atropine, and using forceps, which perfectly steadied the globe. No accident of any kind occurred, and the iris lay in position with the pupil fairly contracted, before the lids were closed. The section had adhered on the fourth day; her recovery was uninterrupted; and on June 6th she was presented convalescent, with a sound cornea; central, clear, round pupil; and excellent vision, to read, &c. [At the time of correcting the press this patient is recovering from the extraction of the left cataract, which I performed ten days since; and so far, the description just given is exactly applicable to this second occasion.]

On reviewing the above cases it will, I think, be admitted that their results were eminently satisfactory. Of the twenty-one operations, nineteen were successful. One failure occurred in a cachectic workhouse patient, with respect to whom an unfavorable prognosis had been given at the outset. The section was in this instance accomplished at once, and no injury was inflicted on the iris; but the disintegration of the hyaloid membrane, and fluidity of the vitreous humour, corro-

borated the evil anticipation which had been formed, and harbingered the issue. The suppuration of the flap simply depended on deficient restorative power, and was in no way connected with the mode of performing the operation. In the other case, failure arose from unhealthy quasi-arthritic inflammation, and was probably traceable to the debauched habits of the patient; for the operation itself had been accurately executed, without any deviation from its desired course or the slightest accident, and, like that in the preceding case, was—considered simply as a surgical process—perfectly successful.

It will be observed, that in but a single case was it necessary to use the bistoury to enlarge the first section of the cornea; this (which it is the especial object of the forceps to facilitate) proving in every other case ample.

Taking the present in connection with the former series, and so completing the entire number of extractions I have performed in the method under consideration, up to the date of the last two cases; it will appear, that in forty-one operations of this kind, the necessity of extending the section arose but four times. In the same number of cases, the iris was compromised four times (and once doubtfully); and of the whole number of forty-one operations four alone failed,—if an old man of eighty, who died three days after operation (from bronchitis supervening on heart disease), be excluded from the catalogue.

It is rather singular, that in every one of the cases of failure the operation had, at the time, been quite satisfactory, as far as respects the corneal section and the freedom of the iris from injury. So that even these failures, regarded in relation to the use of forceps, contribute evidence in support of the practice.

The mode of operating, to which the favorable issue of the above cases is greatly due, needs little further recommendation than the character of its results on a scale thus extended. Yet I may be permitted, in conclusion, to adduce a communication on the subject, *ab extra*; which the kindness and candour of an intelligent practitioner have placed spontaneously at my disposal. Dr. Steventon, late of Cheadle, thus wrote to me, in December, 1859: "Accept my humble testimony to the

efficacy of that invaluable aid to the operation of extraction, which I first observed in 'Guy's Hospital Reports.' I have altogether operated many times, but the 'pleasure' of operating was, until the last season, held in complete subjection. * *

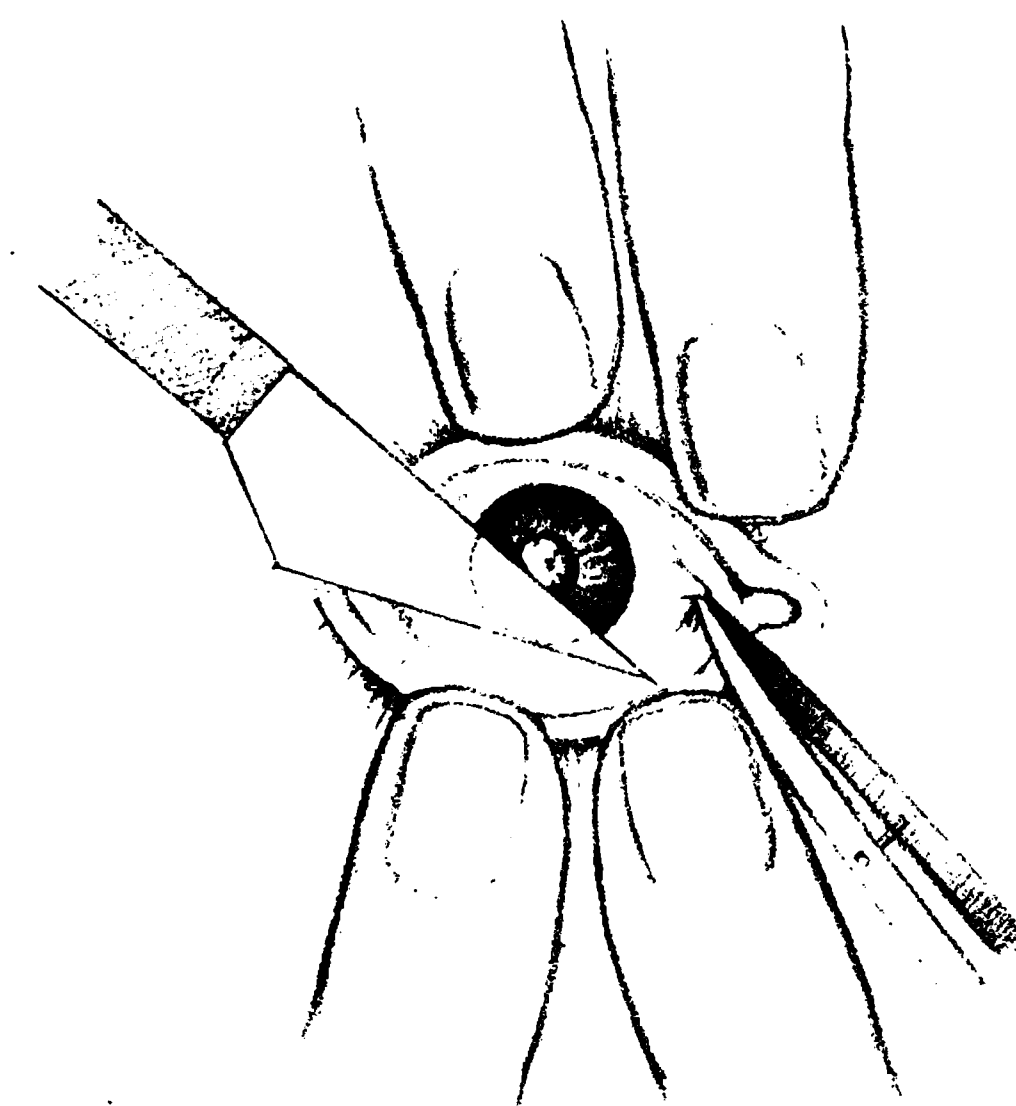
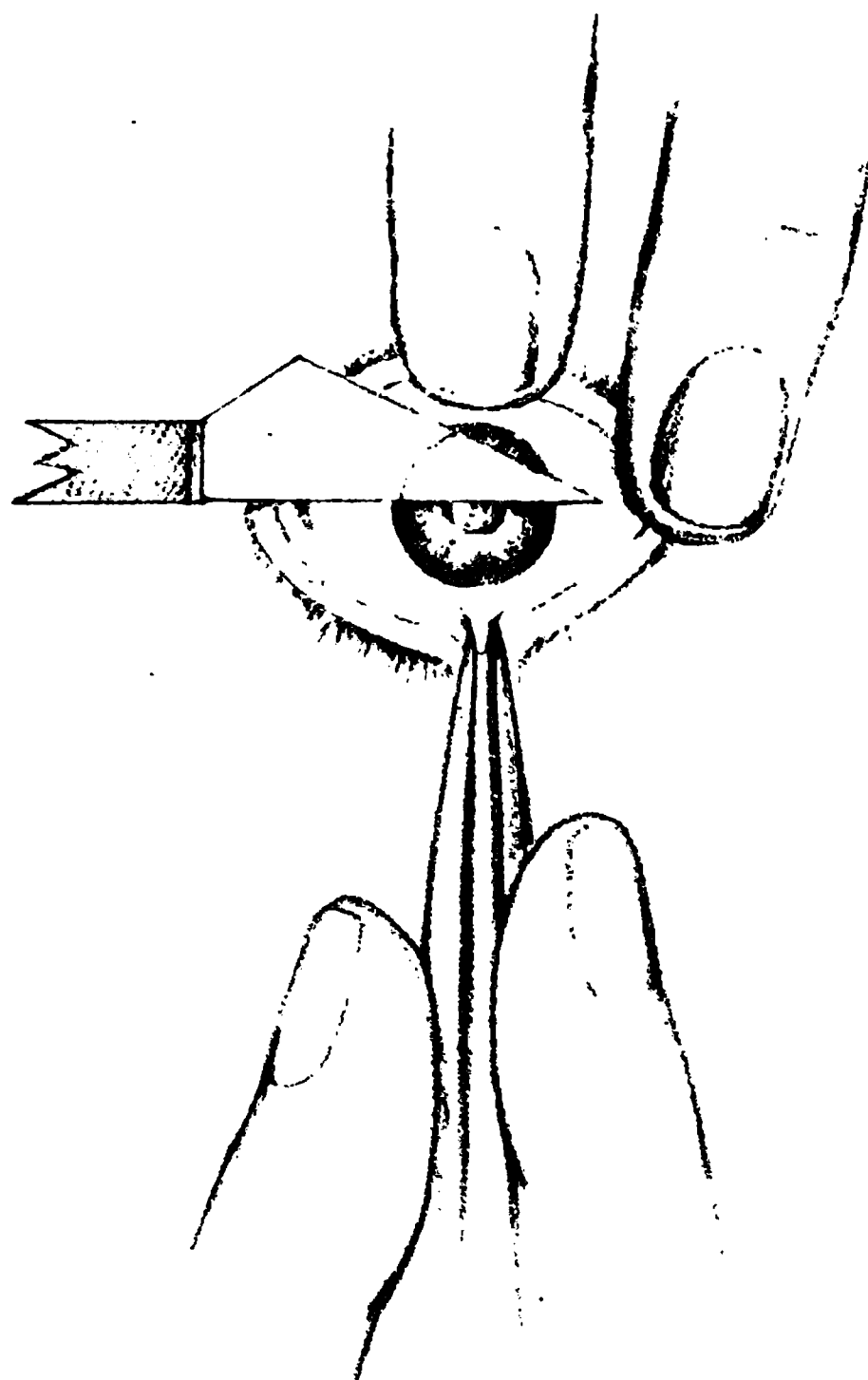
* * Now, however, with the assistance of the forceps, I feel that there is no occasion for hurry; and I have had six successful cases in succession during the last summer, a result which I attribute mainly to having adopted your suggestion.

* * * * In truth, the comfort I have felt ever since my first case under your plan, has left no desire to return to the former."

It is unnecessary to pursue this subject at greater length, or to adduce from the records of the current year additional cases to those already given. Enough has been written in this, and my former papers, to explain the precise object and bearings of the suggestion I have made; enough to show the very general desire entertained for some such accessory in this operation, from its first promulgation to the present time; enough to clear the means proposed from the charges of inadequacy or risk; enough to prove, by a catena of facts, that the mode of operating described is a real improvement on that ordinarily followed, — facilitating the process of extraction, obviating the chief dangers which attend it, imparting greater uniformity to its course, and (as a natural consequence) enhancing the ratio of its success.

The accompanying Plate shows, in figure 1, the mode of operating advocated and exemplified in the preceding pages. The upper fingers are those of the operator, while the lower, which hold the forceps, are those of the assistant.

Figure 2 is copied from the work of M. Desmarres; and possesses interest, as delineating the first crude suggestion for bringing forceps in aid of extraction. The knife and forceps are held by the operator; while the fingers, both above and below, are those of the assistant. The objections to this plan, from the inconvenient position of the forceps, the loss of the support of the finger at the inner canthus, and the operator's non-control of the upper-lid, &c., are too obvious to the practical surgeon to require further comment.



ON
SOME DISEASES OF CHILDREN.

By SAMUEL WILKS, M.D.

IN the present article we intend to bring together some cases of disease as met with in childhood ; and by separating infantile affections from those of adults, we are only pursuing a method which has received universal sanction as one of practical necessity.

IN writing a hospital report, we make no apology for confining our remarks almost exclusively to pathology, and therefore for selecting fatal cases in illustration ; since we think that the opportunities which a large institution affords in allowing its officers to complete their cases by post-mortem examination should be taken every advantage of, and put to their proper use in a journal of this character ; while, on the other hand, we consider that all those detailed relations of symptoms which are familiar to every practitioner may be usefully avoided. It is sometimes urged, we know, that morbid anatomy may be too zealously studied ; that the effects of disease may thereby be substituted for the disease itself ; and that the regarding of all maladies from the structural point of view can lead only to error. In answer to this objection, it may be said that the wrong interpretation of morbid phenomena can in no way interfere with the fact of their existence ; and this fact of their reality is alone sufficient to establish their importance. It should also be remembered, that if a certain nosological appellation has been suggested by any remarkable morbid changes discovered in an organ after death, it does not of necessity follow that the name

always includes in it the extremest possible alterations which that organ may undergo—that, for example, when it is asserted that a patient has phthisis, it is not necessarily implied that he has a total disorganization of the lungs, or that if he has Bright's disease, that he is suffering from an atrophied granular kidney: all that is intended is, that the patient has a disease whose tendency is to the production of that extreme change if protracted to a period sufficiently lengthened. So we think that in all cases where a well-marked anatomical condition is found, it is well to designate the malady by a name suggestive of that condition, and to apply the same term to all those cases where from a similarity of symptoms we cannot but judge that the same visible changes would ultimately ensue, even though we do not believe that they have reached that stage at the time they are under notice. Even if we do not name our maladies from their anatomical peculiarities, the study of the morbid conditions which are found after death is of the greatest value, as pointing out to us in what direction we may look for a fatal result. Thus, in the following pages, if we see scarlatina is fatal by the implication of certain organs, or that children who are burned die with definite affections, it is of the utmost practical importance to bear these in mind, since we are thus better prepared to anticipate these morbid phenomena, or even to prevent their appearance. These few preliminary remarks we have made in defence of the study of morbid anatomy, and in answer to the inquiry *cui bono* which has been raised by some of the older members of our profession in reference to pathological pursuits.

CEREBRAL AFFECTIONS OF CHILDREN.

In applying the above remarks to cases of head disease, considerable difficulties arise, owing to the various morbid states which are found after death in the brain; and from the fact that often nothing appreciable is discovered in cases where yet the morbid phenomena observed during life are explicable only on the supposition of disease of this organ. Thus it is that so many writers on these affections have classed together cases according to certain symptoms observed during life, and been more content with associating them by these means than by

any pathological appearances found after death. A living writer, for example, from the great difficulty in distinguishing symptoms during life, has placed together the ordinary tuberculous hydrocephalic disease and acute meningitis; between which the French have long, and we think rightly, maintained a difference. We consider that, if in a given number of cases with symptoms more or less allied, certain definite pathological conditions are constantly found, we have, in the latter, sufficient grounds on which to form a distinction of a generic kind; and by so doing we are enabled to get rid of some of the more marked forms of disease, and thus are better prepared to deal with those more obscure diseases which have not yet succumbed to any definite classification. For instance, we believe that *tubercular meningitis* may be shown to be as distinct an affection as any in the nosology; also *acute simple meningitis*; also *acute arachnitis* arising from external causes. These affections constitute the three most-marked acute diseases of the brain occurring in children. Besides these, however, we meet with a large number of cases where the post-mortem appearances are absolutely nothing, and where indeed we could scarcely expect to find it otherwise. We allude especially to cases of *convulsions* in children, where no morbid changes are discovered; and when we consider that a child may have several convulsive attacks and speedily recover, and then have another which only a degree more severe shall prove fatal, it is clear that no very great change could occur in an organ which would have perfectly recovered itself had the fit been only one degree less in severity. How slight the changes must be in the brain which may produce important symptoms, we all know; but this fact was most vividly impressed upon us by the case of a boy in whom Mr. Birkett tied the carotid artery. Soon after the operation, the lad experienced some weakness of the arm and leg of the opposite side of the body, and which amounted in a few hours to a complete hemiplegia. This remained for a day or two, when it gradually subsided, and he again recovered perfect use of his limbs. We argue from this, that although during the time of the paralysis the function of certain important central parts of the brain was totally arrested, yet, could they have been seen at that time, no textural alteration would have been discoverable, seeing that the organ could in so

short a time again completely recover itself. We know also this fact from the fatal cases of epilepsy in adults, and in others where from local disease of a chronic nature a convulsive attack may bring them speedily to an end. Analogous facts are witnessed in fatal acute mania. Amongst the more acute diseases of the brain in children, we might allude to cases where there is evidence of a slight degree of inflammation of the brain; which although not sufficiently well marked to enable us to place them in any of the preceding categories, may represent their early stages. Of these we shall offer one or two examples.

Amongst the more chronic diseases of the brain an equal or greater difficulty exists in an attempt at classification. *Chronic hydrocephalus* is a very favorite appellation for all long-standing affections of the brain in children, if the head be at all large; shewing how much obscurity still attaches to this form of disease. The term is probably only correctly applied to that affection where the principal condition is a large ventricular effusion leading to increased size of the head; one of the most remarkable examples of which is that of the lad Cardinal, whose skeleton is in our museum. A similar effusion, however, may arise from local causes, as a large scrofulous tubercle in the brain; and which, therefore, cannot in strictness come under the category. There is also a simple effusion due to mere passive exudation, and which during life is often spoken of as hydrocephalus; we allude to those cases which were long ago elucidated by Dr. Gooch and Dr. Marshall Hall. By way, then, of classification, we think we can distinguish between cases of *simple passive effusion* arising in anæmic infants; cases of effusion arising from a local cause, as *scrofulous or other tumour*; and cases which we may call *true hydrocephalus*. Besides these three forms of hydrocephalus, we have seen two or three examples of an affection in which, during the whole period of childhood and youth, obscure cerebral symptoms have existed, denoted by obtuseness of mind; and in which, upon the occurrence of death, the only marked condition has been a large ventricular effusion. It may be that such cases are the result of some disease in childhood, but which, being recovered from, nevertheless impairs the whole cerebral substance, although nothing but the effusion is discoverable after death.

Tubercular meningitis, or acute hydrocephalus.—We consider that the cases included under these terms are so distinctive, that there can be no hesitation in placing them together under one head. We prefer, however, the former appellation, as being more characteristic, since the latter is so indefinite that various affections have been described by authors under its name. The character of the inflammation is of that kind which renders it at once recognisable even should no tubercles be present; these bodies are, however, to be found in the large majority of instances; but even if they should not, they will be met with in the lungs or other part of the body, so as to sufficiently indicate the constitutional nature of the affection. We cannot indeed remember a single case in which certain well-marked inflammatory conditions have been present without the discovery of tubercle in some part of the body. These appearances, in a few words, are effusion of tenacious lymph at the base of the brain, ventricular effusion with softening, and tubercles in the pia mater. The surface of the brain, on removal of the dura mater, is very often found flattened, owing to the pressure excited upon it by the fluid in the ventricles, and which forces it against the skull so as to obliterate the sulci between the convolutions; the meningeal inflammation shown by the lymph at the base is scarcely to be discovered on the hemispheres, being appreciable only as a slight greasiness when the finger is passed over their surface. The fluid in the ventricles exists to a considerable amount, and is often somewhat turbid, whilst the surrounding parts are soft. The lymph spoken of at the base is mostly confined to the neighbourhood of the optic commissures and infundibulum, and is of a greenish colour and tough consistence. Similar lymph, however, may also be found in the fissure of Sylvius, and this is often of a tuberculous character or has tubercles mixed with it. Besides these appearances of an inflammatory kind, tubercles are mostly found in the membranes; these are not often seen on the arachnoid, but are to be met with in the pia mater, especially in those parts which dip down between the convolutions; thus it is always necessary, before pronouncing against the existence of tubercles, to take a slice of the cerebral surface, strip off the membranes, and examine these vertical portions.

These are the principal morbid conditions which are found, and are sufficient to indicate the difference between tuberculous meningitis and other acute affections presently to be mentioned. The subject of tubercle has some light thrown upon it by the consideration of its presence in this form of disease. It is, as is well known, still disputed what period of time is required for the production of tubercle; whether indeed it be a rapid or slow formation; and when associated with inflammatory products, whether it has preceded or indeed instigated the inflammation; or whether, indeed, it be not the inflammatory exudation which has put on this peculiar character. This question is sought to be determined by the presence or absence of the fact that tubercles may be found accidentally in the body. The advocates of the slow production, or indefinite age of tubercles, state that they may be found in the bodies of those who die from accident; but in answer to this, our own experience is that only two cases of this kind have come before us where tubercles were found in the lungs, and in one of these pulmonary symptoms had existed. As regards, however, the brain, to which our remarks are especially directed, we have never yet met with a single instance of tubercle of the brain apart from recent inflammatory exudation and unaccompanied by symptoms during life. This would seem to show that tubercles cannot long exist in the cerebral membranes without an inflammation and its accompanying symptoms being set up; and it might indeed suggest whether, from never finding them apart from recent exudation, they be not of equally acute formation as the lymph itself. There can be no doubt that in the peritoneum and pleura an inflammation may be excited which, from the constitutional peculiarity of the patient, shall assume the tuberculous form, and therefore there is every probability of the same occurring in the brain. The above facts would seem to show that this is often the case; and the nature of the soft granulations often met with in the fissure of Sylvius also point in the same direction.

From the observation of this class of cases it would also appear that this tuberculous meningitis is mostly a secondary affection, for in no single case which we have yet examined have tubercles been absent from the lungs, even in the youngest infant. It would seem that a tuberculous affection

of the lungs or brain, as the sole disease met with in the body, is rare; but as, in our experience of a large number of cases, a tuberculous disease of the lung may be met with without any corresponding affection of the brain, but, on the other hand, a tuberculous brain never found without a similar condition of lungs, it would follow that the proposition just now laid down is true—that tuberculous meningitis is generally a secondary affection, or follows the development of tubercle in some other part of the body.

As before said, our great object in this paper being to define accurately the pathology of the disease, we have selected fatal cases. These, for the most part, occurred in Guy's Hospital; a few only in dispensary and private practice. Their source will explain a peculiarity about them, that many commenced in the hospital in the persons of children who were under the surgeons for local diseases, and it will be observed that these for the most part were affections of the hip-joint. Whether this fact, deduced from so few cases, is sufficient to prove the more than usual scrofulous or constitutional nature of hip-joint disease, we should not dare to say. Another fact to be observed is that the majority of patients were boys; this more frequent occurrence of the disease in the male sex is, we believe, in accordance with the observation of most authors. We have also given some outline reports of the disease as it occurs in adults of young and advanced age, in order to prove the identity of the affection under all circumstances. The first case recorded is a good example of tuberculous meningitis, and shows how difficult it is in the commencement of the disease to distinguish it from gastric fever. It is also interesting to note that, at the suggestion of a friend, calomel was given and pushed to its utmost limits, but without the slightest effect on the progress of the disease.

CASE 1.—A girl, æt. 4½, was under our care at the Surrey Dispensary. When first seen she was suffering from febrile symptoms, and the case was considered to be one of gastric fever. She had been ailing thus for a week; but on questioning the mother it was learned that the child had not been quite well for three months, that she had lost her appetite, and disliked to go to school. A week after her seeking advice the child was visited at home, and was then found very ill, lying quiet, making no complaint, in a high febrile state, bowels confined, and obstinate vomiting. She thus continued for a few days, gradually getting worse, more drowsy, &c. A friend who visited the patient, wishing to try the ordinary plan of treatment by mercury,

consent was given; leeches had already been applied to the head, and now a grain of calomel was administered every four hours. The latter remedy was persisted in so as to give it a full trial, and was not left off until the child was salivated. She subsequently had an attack of convulsions, constantly rolled her head in the pillow, was semi-conscious, and heaved deep sighs. She then fell into a state of coma, but still threw her head about; pupils dilated; finally a mucoid film came over the eyes, and constant convulsive twitchings until death ensued. Well-marked head symptoms had thus prevailed for three weeks. *Post-mortem examination*—The mouth was ulcerated, as if from the effects of the mercury. Surface of brain greasy, and convolutions so compressed that not a drop of fluid to be seen on the surface. At the base there was much tenacious lymph covering optic commissures, &c. In this, and especially in the fissure of Sylvius, there were hundreds of tubercles conglomerated in masses with lymph; in the pia mater of the surface the tubercles were also numerous, but scattered. The ventricles contained a large quantity of clear serum; the septum lucidum and fornix partly destroyed, and adjacent parts in a semi-fluid state. The latter, when placed beneath the microscope, displayed numerous fatty granules; these, however, were not combined in masses, but were found merely along and surrounding the course of the blood-vessels. The *lungs* contained numerous miliary tubercles.

CASE 2.—A little girl, æt. 1½, was brought among the out-patients, having been ailing about two or three weeks, with fever, and disinclination for food; she was then apparently suffering from cerebral disease. On the following day she became insensible, and thus continued for six days until death. When visited at home, on the first of these days, the child was found lying on its back, arms and legs stretched out; eyes closed, no strabismus, pupils contracted and turned up as in sleep, and covered with a mucoid film; bowels confined; about every half-hour a slight, but general, convulsion. On following days the child still lay stretched out in the same stiff manner, with the thumbs and toes flexed; the pupils still contracted. The day before death the left side of the body appeared quite paralysed, as the limbs lay quite motionless, and dropped heavily when raised, while the right constantly moved. The pupils remained contracted until the last, and although insensible for several days, she continued to swallow.

There was no permission in this case for a post-mortem examination, but we mention it because it presented several points of interest. The state of the *pupil* was remarkable in being contracted, for dilatation is the rule, especially if there be much effusion in the ventricles. It is highly probable that the condition of the pupils depends upon accidental circumstances, as, for example, what part of the brain is especially affected in any individual case. The rule in hydrocephalus is a sluggishness of the pupil at the early period of the disease, and a dilatation towards the close; how far this depends on implication of those parts of the brain whence the optic nerve has its source, or how far on affection of the nerve itself from

surrounding inflammation, is difficult to say. Contraction of pupil in cerebral affection is generally, we believe, observed in those very severe forms of apoplexy where a large quantity of blood is poured out into the ventricles and runs down to the base; also in those cases where a sanguineous effusion has occurred in the substance of the pons varolii. It is clear from this, that the pupils are variously affected as different parts of the brain are involved. As showing how slight a matter will influence the size of the pupils, we may mention a case which we witnessed some years ago; it was that of a man who had long been bedridden with softening of the brain and large ventricular effusion; on our first visit to him in this state, we made a note of the fact of one pupil being larger than the other; on a second visit, the pupil which had been the smaller was now the larger, and *vice versa*. It was then remarked that he was lying on different sides on these two several occasions, and that it was in each instance on the lower side that the pupil was dilated. We requested that before our next visit he should be placed on the side on which he lay when first seen; this was done, and it was then found that a change had again occurred, and the same pupil was dilated as in the first instance. So also on subsequent occasions, which enabled us to prove that the gravity of the fluid in the ventricles was sufficient to influence those parts of the brain whence the optic nerve had its source.

Another point of interest in this case was the *mucoid film* on the eye; this appearance of the half-closed eye appears to point to a very low state of nervous power, since the sensitive nature of the conjunctiva is so lost that there is no effort made to get rid of the secretion, nor of any floating foreign bodies which may have become adherent to it. We have generally been in the habit, and we think correctly, of connecting this with cerebral affection, and in difficult cases of diagnosis of looking upon it as one point in favour of the disease being within the brain.

The *hemiplegia* may be noticed also in this case as one of very common occurrence towards the close of hydrocephalus, and depends no doubt upon one side of the ventricles being more softened than the other; the optic thalamus or corpus striatum being more deeply involved in the central softening

on one side. This, however, is very difficult to demonstrate after death.

The *convulsions* in these cases are dependent on the affection of the surface of the brain, just as the paralysis is owing to softening of the central parts; these two facts seem now to be clearly ascertained. In the above case we were witness of what the mother called inward convulsions; and we mention this because we know medical men who ignore such statements, and recognise those only as convulsive fits where the paroxysms are extreme in character. There can, however, be no doubt, that all degrees of convulsion occur, and that the eye of the anxious mother, watching over the cradle of her child, can perceive slight changes in the countenance or expression, and which are, in reality the involuntary muscular spasms which, however slight, are perhaps about to usher in more terrible paroxysms. In this case we regarded the mother's wish, and watched with care the form of the child when every now and then a cloud would seem to pass over its face, and at the same time the body would appear slightly stretched out, indicating, as it was called, the inward convulsion.

The following fourteen cases show the ordinary appearances in the brain, and by comparing them together their resemblance will be at once seen :

CASE 3.—This was a child, æt. 2 at death. The history given was that he had had scarlatina about three months before, and that soon afterwards the hip-joint became affected; for this he was admitted under the surgeon, and placed in bed. It was difficult to ascertain exactly how long cerebral symptoms had existed, but it appeared that about a fortnight before his decease he was seized with vomiting, and afterwards fell into a drowsy, listless state, from which he could only be roused by shaking, and then with difficulty; he at last became unconscious, with widely dilated pupils, and so remained until death; the only marked symptoms appeared to be gradually increasing coma. *Post-mortem examination*—Surface of brain slightly greasy from the most trifling amount of exudation. Upon stripping off the membranes numerous tubercles seen in the pia mater; at base of brain a considerable effusion of yellow lymph covering the pons, optic commissures, and neighbouring parts. Ventricles immensely dilated with a clear fluid, four ounces of which were easily collected; the central parts quite diffuent and walls soft. Exudation-cells found therein, and fatty granules surrounding the blood-vessels. The surface of the ventricles slightly granular. Cerebral structure generally was soft. Both *lungs* filled with tubercles, both of the hard miliary and the yellow softer variety. Bronchial glands tuberculous; also peritoneum. Hip-joint acutely inflamed, with erosion of the cartilages.

CASE 4.—A child, æt. 4. When first seen had been ill a fortnight, and now

suffering from well-marked symptoms of cerebral disease. During this period he had complained of pain in the back of the head, sickness, screaming at night, &c. Now he lies on his back, and is in constant fear of being moved, as it increases his headache; constant sickness as before. He occasionally draws up his legs and arms, and then extends them; but no decided convulsions: thumbs turned in on palms. He afterward sank into a state of coma, with pupils widely dilated. *Post-mortem examination*—Surface of hemispheres almost dry, or only a little greasy exudation to be scraped from them. At base a considerable quantity of inflammatory effusion within the pia mater; the optic commissures, and parts around, covered with an exudation of lymph. Upon stripping off the pia mater from the convolutions, tubercles were found in the membrane, especially in the fissure of Sylvius. Brain itself flat on superior surface, from the pressure of fluid within the ventricles, and corpus callosum bulging out for the same reason. The fluid within amounted to about three ounces, and appeared to consist of little else than water, having a specific gravity of 1001, and becoming only slightly opaline by heat. The septum lucidum, fornix, and the ependyma, very soft, being in fact semi-fluid. Examined microscopically, these were found to contain exudation-globules, and fatty granules surrounding the capillary vessels. The cerebellum contained three or four hard scrofulous masses in the cineritious substance, each being about the size of a pea. The lungs contained miliary tubercles. Bronchial and mesenteric glands also. Spleen and kidneys contained a few tubercles. There was also post-mortem solution of the stomach, and discharge of contents into peritoneal cavity.

CASE 5.—A little boy was slowly convalescing from a severe burn, when he gradually became drowsy, and died in a few days in a state of coma. On *post-mortem examination*, the ventricles were found much distended with fluid, and all the boundaries of cavities so soft that they were almost semi-fluid. The pia mater contained abundance of tubercles.

CASE 6.—Boy, æt. 4, admitted under Dr. Wilks's care. When first seen, exceedingly ill with cerebral symptoms, he was in a semi-conscious state; the head thrown back, pupils widely dilated, fingers contracted, with slight convulsive twitchings. These symptoms remained for a week, when he died. He had been ailing for some time with a cough, which was thought might be whooping-cough; and this was its character when first seen, a week before death. *Post-mortem examination*—Surface of brain rather flattened; sulci very shallow; no effusion. At the base there was a quantity of lymph covering the optic commissures and parts around, passing on to the cerebellum. This was very plastic, being solid and tough. The ventricles were widely dilated with serum, which was not quite clear, containing a few shreds of softened brain-substance; the septum being quite destroyed, and adjacent parts diffuent. The microscope showed abundance of granular exudation in all these softened parts. Numbers of tubercles were found in the pia mater covering the brain. Lungs contained both miliary and soft tubercles. Bronchial glands enlarged by tubercles, one of which pressed on the pneumogastric nerve. Peritoneum covered with tubercles; also mesenteric glands. Liver and kidney none. Spleen a few.

CASE 7.—Boy, æt. 6. Had long been suffering with hip disease, when symptoms of cerebral disease appeared, and it ran its usual course. *Post-mortem-examination*—The appearances in brain were as in other cases, but less marked. Surface flattened, and arachnoid slightly greasy; small quantity of transparent lymph at base. Numerous tubercles found scattered through the pia mater. Ventricles contained a

large quantity of fluid, and surrounding and central parts very soft. *Lungs* contained numerous tubercles. No tubercles in any other part.

CASE 8.—Boy, æt. 8. For two years he had suffered from disease of the hip-joint. For some weeks he had kept his bed, and wasted away, indicating some severe internal disease; when, a few days before death, convulsions came on, followed by coma, and so he died. *Post-mortem examination*—The surface of brain was seen to have a slight exudation upon it between the sulci, but at the base considerable effusion. On stripping off the pia mater, a large number of tubercles were found in its meshes; and in the fissure of Sylvius a thick mass of them. The ventricles were much distended, with two ounces of clear serum; the central parts were not particularly soft. *Lungs* contained miliary tubercles, as well as larger, softer masses of yellow deposit. Bronchial, mesenteric, and lumbar glands enlarged by tuberculous matter. Peritoneum none; mucous membrane of intestine contained them; kidneys also.

CASE 9.—Boy, æt. 8. Was said to have been very delicate, and had suffered from various ailments. A week or two before death he sank into a listless condition, and soon into a state of perfect unconsciousness, with the pupils dilated, and finally he had general convulsions. The brain presented the usual appearance, with lymph at the base, and numerous miliary tubercles in pia mater; also one small mass of the same, about the size of a pea, in the cineritious substance of the cerebrum. Ventricles contained about two ounces of fluid. *Lungs* contained tubercles, and bronchial glands; also few in kidneys.

CASE 10.—A boy, æt. 9. Had been labouring under empyema for several months; a discharge was taking place from the chest, and a cure was in process, when he was seized rather suddenly with cerebral symptoms of the usual character, soon followed by convulsions, and partial paralysis of the right side. *Post-mortem examination*—Surface of brain not flattened, but considerable serum in subarachnoid space. At base a patch of tough lymph, in which was some tuberculous matter; there were also tubercles throughout the pia mater. Increased fluid in ventricles, and surface granular. *Lungs* compressed by the pleuritic inflammation, but contained some tubercles.

In this case the unusual appearance of surface of brain was due to atrophy arising from the long-standing disease in the chest.

CASE 11.—Girl, æt. 10. About eight weeks before her death she used to complain of feeling heavy, and at the expiration of three weeks was reluctant to go to school or to play. She then became peevish, listless, and drowsy. This increased until seen two weeks before death, when she was in an almost unconscious state; skin hot, pupils dilated; often threw her head and arms about. She never had any convulsions, but gradually fell into a state of profound coma, with widely dilated pupils. *Post-mortem examination*—Surface of brain somewhat flattened; at base, a patch of tenacious lymph covering optic nerves and adjacent parts. Ventricles contained between two and three ounces of fluid; and surrounding parts soft, and containing inflammatory products, seen by microscope. *Lungs* also tubercular.

CASE 12.—Girl, æt. 11. Had measles; subsequently pleurisy; and two weeks

before death she was seized with symptoms which were supposed to indicate gastric fever, but it was soon evident that they were due to cerebral mischief, as she became drowsy, and at last comatose. Towards the last, paralysis of the right side came on. *Post-mortem examination*—Surface of brain flattened; effusion of lymph at the base. Tubercles in membrane; much ventricular fluid. *Lungs* filled with tubercles; also peritoneum, glands of intestine, liver, and spleen.

CASE 13.—A boy, æt. 13. Was long under the writer's notice for a scrofulous liver; for about a year and a half he had been suffering from a gradually increasing enlargement of the abdomen, with wasting of other parts of the body. This was due to an enormous increase of the size of the liver, which was considered, judging from the highly strumous nature of the boy, to be lardaceous. His complaints were those due merely to debility. About a fortnight prior to his death he became feverish, lost his appetite, and took to his bed; he gradually fell into a semi-conscious state, but never had any more marked symptoms. *Post-mortem examination*—Surface of brain flattened; slightly greasy. A quantity of tough, semi-transparent lymph at the base of the brain. Numerous small tubercles in meshes of pia mater. Ventricles contained a large quantity of clear fluid; two or three ounces. Central parts very soft, and whole surface of ventricles granular. *Lungs* contained tubercles; also bronchial glands. Pericardium universally adherent. Tubercle in intestine and mesenteric glands, also lumbar glands and kidney. Liver lardaceous or waxy, weighing five pounds and a quarter.

CASE 14.—A boy, æt. 13. When first seen had been ailing about a fortnight, with feverish symptoms and headache; but it was not very certain that the case was not one of fever. He subsequently became lethargic, and was once or twice sick, and finally the pupils became dilated; there were otherwise no very marked cerebral symptoms. *Post-mortem examination*—Body wasted; abdomen flattened. Surface of brain had slight exudation, and hemispheres somewhat flattened; a large patch of semi-transparent, tenacious lymph at the base; numerous tubercles in meshes of the pia mater, especially in the fissure of Sylvius. The ventricles much less affected than generally seen; fluid only slightly increased in quantity, and circumference but little softened. *Lungs* contained a few miliary tubercles, and also lobular hepatization of some parts. All the other organs healthy.

CASE 15.—Boy, æt. 13. Two months before his death, this boy began to complain of severe pain in his right side, accompanied with difficulty of breathing; this was attributed to a fall which he had received three weeks before; this chest affection went on until about ten days before death, when he began to complain of his head, and gradually sank into a drowsy state and soon became quite comatose. This insensibility was his only marked symptom; the pupils were variably and unequally dilated and covered with a mucoid film; abdomen contracted; skin dry and harsh; body wasted. *Post-mortem examination*—Surface slightly greasy and the anterior lobes slightly adherent by few points of lymph to the orbital plates. The base was covered with a tenacious, translucent lymph. The pia mater was occupied by tubercles in very large number, and these of two kinds; some being firm, small, and apparently of some age, while others were large and soft, and evidently of recent formation. In the fissure of Sylvius these lay so crowded together that they consisted rather of a layer of lymph of a granular character. Ventricles contained four ounces of clear serum; central parts soft, though not exceedingly so; the inner surface of the ventricles throughout granular; a mass of firm yellow tuberculous

matter in the left lobe of cerebellum. *Lungs* both adherent to chest by scrofulous lymph; that is, by a material resembling that found at the base of the brain: the costal pleura also covered with lymph of a granular character, and thus resembling groups of tubercle. Both *lungs* filled with tubercle. No tubercles in peritoneum, but some in mucous membrane of ileum; also in mesenteric and lumbar glands. Tubercles also on circumference of liver, spleen, and kidney.

CASE 16.—Boy, æt. 16. This lad was only seen once about an hour before death, the case being stated to be one of fever; he was then sensible, answered questions rationally; he had strabismus, and the pupils were of unequal size; he soon afterwards had an attack of convulsions and died. The father stated that he thought the boy had something the matter in infancy, but that subsequently his health had been good; about a fortnight before his death, having then been ailing two days, he came home ill; being better on the following day he returned to his work, but was again obliged to desist; he was then put to bed, where he continued in a febrile state and condition of listlessness; he was sensible; had no headache, nor sickness, but stated that he merely felt “odd.” *Post-mortem examination*—The hemispheres much flattened, so that appearance of convolutions almost lost. Serous membrane had lost its natural glistening surface, but no lymph; on separating the convolutions, the pia mater was found thickly strewed with tubercles in all parts; at the base there was a large patch of lymph. Ventricles contained two ounces of fluid, this was clear but became quite opaque on boiling, was alkaline, and had a sp. gr. of 1007. The surface of lateral ventricles, as well as that of the fourth, was universally granular. The surrounding parts were rather softer than other parts of brain; the microscope showed nothing more than numerous granules surrounding or accompanying the capillary vessels. The gray matter was soft, and adherent to the pia mater, so that the membrane could not be removed without tearing the former. *Lungs* contained numerous tubercles. Lymphatic glands and serous surface free; but spleen contained a large quantity, and also liver and kidney some.

We will now give a few cases of the disease as occurring in older persons, for the purpose of showing the identity of the affection.

CASE 17.—Boy, æt. 18. Remarkably intelligent lad, and coming from a consumptive family. He had had a cough for years; about twelve days before his death he began to feel drowsy, became strange in his manner, and fell at last into a complete insensible condition. He was only seen the day before his death. *Post-mortem examination*—Surface of hemispheres somewhat flattened, and the arachnoid greasy, that is, was covered with a small quantity of inflammatory exudation, which could not be seen, but could be scraped off with the scalpel. Cerebral substance rather soft. Ventricles contained a considerable quantity of perfectly transparent fluid, parts around softer than natural. Effusion of lymph over optic commissures and adjacent parts. Tubercles found in pia mater among the convolutions. *Lungs* subject of chronic phthisis and intestines of tubercular ulceration.

CASE 18.—Lad, æt. 18. Had long suffered with disease of the hip-joint. Two weeks before death head symptoms came on, with oppression and drowsiness, ending in coma. The post-mortem examination showed lymph at the base of the brain;

large ventricular effusion, with softening of the central parts. *Lungs*, spleen, and kidneys contained tubercles.

CASE 19.—A lad, æt. 10. He had typhoid fever six months before his death, at which time he had more than usual cerebral symptoms, and he was a long time convalescing. He, however, at last recovered, and remained well until three weeks before his death, when he was seized with severe pains in the head. These continued for ten days, when he was visited by the writer; he was found then complaining of headache, throwing his head about and shrieking out; the skin very sensitive, and a great dislike to be touched; delirious at night; much fever; pulse slow; pupils sluggish; abdomen flat. These symptoms continued until death. *Post-mortem examination*—Surface of brain flattened; no lymph seen here, but a small quantity at the base. Ventricles contained much fluid, and septum and surrounding parts very soft. Pia mater contained tubercle; there was much in the fissure of Sylvius and also in plexus choroides of fourth ventricle. *Lungs* and bronchial glands contained tuberculous matter.

CASE 20.—A young man, æt. 21. Had been suffering from phthisical symptoms for several months, but was able to follow his employment. A week before his death, having been ailing with a cold for some days, he took to his bed, with severe cough, and not until four days before his death did he manifest any cerebral symptoms, when he became feverish, wandering in his mind, with inactive pupil, &c. He continued delirious and restless until death, without any more manifest symptoms; the case much resembling one of fever. *Post-mortem examination*—Surface of brain slightly greasy; at base a quantity of tough, semi-transparent lymph, and numerous tubercles in pia mater. The ventricles contained only about three times their usual amount of fluid; septum lucidum thin and soft. Surface of ventricles in places granular. The *lungs* in early phthisical condition; tubercular peritonitis.

CASE 21.—A young man, æt. 25. Had been suffering from phthisical symptoms for a twelvemonth, when, a week before his death, he complained of headache, and on following day drowsiness; he then sank into complete coma, with occasional convulsions. For two days before death he recovered his consciousness; then a convulsive seizure came on, and he died. The brain showed but little inflammatory exudation, and the ventricular effusion was not increased nor the walls of the cavity softened; the pia mater everywhere contained abundance of tubercles. *Lungs* disorganized.

CASE 22.—A man, æt. 35. Had been suffering several months with phthisis, when, towards the close of his illness, he was seized with several epileptiform fits. The *post-mortem* showed tubercles in pia mater, also a mass the size of a pea in the gray matter of right hemisphere. Surface of ventricles granular. *Lungs* disorganized, and bowels ulcerated.

We will merely give two more cases of tuberculous affection of the brain as occurring in persons of considerable age, to show the resemblance of these to the same disease in children.

CASE 23.—A man, æt. 45. He was an intemperate man, and having had a severe fall, had been invalided for several weeks, when, between two and three weeks before death, he began to complain of his head, and had sickness. He took to his bed

in a few days, and when seen was scarcely in a conscious state; he could give his name, but no other particulars; he had constant convulsive twitchings; he gradually passed into a state of coma, and thus died. *Post-mortem examination*—On the surface there was lymph effused between the convolutions, although not so much as at the base, where a large quantity of firm lymph existed. The pia mater everywhere was filled with miliary tubercles, small and soft. Ventricles contained two ounces of fluid, and walls very soft and surface granular. Fornix presented granule-masses by the microscope. The *lungs* filled with miliary tubercle, peritoneum covered, and bowels ulcerated. Liver in an advanced state of cirrhosis.

CASE 24.—Man, æt. 48. This man, when first seen, was said to be labouring under bronchitis, arising from a cold; he, however, presented the appearance of a man with fever, pyrexia being great, accompanied by delirium, &c. He remained in this condition a month, when he died. The *post-mortem examination* showed a little lymph on surface of brain, tubercles in pia mater, and two small yellow deposits in the cerebellar cineritious matter. *Lungs* filled with tubercle, also kidneys and genital organs, as well as lymphatic glands.

We think a perusal of the above cases will be sufficient to show that one form of disease has alone been selected, and that they are sufficiently characteristic to distinguish it from other cerebral affections. It is true that no individual cases of disease are exactly alike, either in extent or intensity, and thus it may happen that the surface of the brain in one instance may be more especially affected and the ventricles in another, and the symptoms resulting therefrom differ, as convulsions, paralysis or coma being the most prominent. It is highly probable that the substance of the brain is affected throughout in many of these cases, but the inflammation supposed to involve more particularly the surface and ventricles, because the exudations are more appreciable here than in the solid cerebral matter. Some of the above cases show that the symptoms may be little more than fever, drowsiness, and final coma; these indeed being, as Cruveilhier remarks, the only symptoms common to all inflammatory affections of the brain. It is for this reason that so much obscurity exists in the earlier stages of this disease, and that it is so difficult often to distinguish it from fever. The condition of the abdomen is one of great importance in the solution of the question, as we had occasion only lately to remark; for being called to a young girl who was said to have been ill a fortnight with head disease, and who had consequently been leeches and kept low, we found her lying prostrate in bed, in nearly a senseless state, but

with a full, tumid abdomen; a very opposite state to the contraction of this part observed in cerebral affections, and associated with a similar contraction of intestine and constipation. We had little doubt that the case was one of fever, and stimulants and support being accordingly given, the patient speedily recovered. It will be observed that in one of the above cases an extreme sensitiveness of the skin is made mention of, and it may often be observed that with pains in the limbs, and increased sensibility of the surface, there is a general dislike to be disturbed. This fact is made use of by Mr. Stocker, of this hospital, as a help in diagnosis, and illustrates well the means which a man of experience may employ, and which yet can scarcely find a place in a written treatise on disease. We have heard this gentleman constantly remark that, in a questionable case of fever and head disease, the way in which the patient deports himself, in reference to his willingness or repugnance to be touched, aids him in his diagnosis either in favour of fever or brain disease respectively. On the attempt being made to raise the patient's nightdress to examine for eruption, &c., if the case be one of fever the patient assists in drawing up his clothes, whereas if it be one of cerebral disease resistance is made, and, if the patient be a child, also a whining and a coiling up on the side, showing that any movement is annoying. In the case of fever the patient is in too senseless a condition to heed any disturbances of the kind, and, automaton like, in his partial consciousness attempts to do what he sees is required.

Tubercular disease of the brain-substance.—It will be observed that very rarely is there any tuberculous matter found in the brain in cases of tuberculous meningitis; the affection of the membranes and that of the brain being different. We may therefore, practically, regard the deposits in the brain as constituting distinct affections; for example, in Case 38. Another case, which occurred under our care, was in an adult, as follows:

CASE 25.—A woman, æt. 30, married. Ten months before death she miscarried, and since that time her health had been failing, and amongst other symptoms she had pain in the head, followed by loss of memory, indistinct vision, and, subsequently, several fits. When seen a month before death, her mind was impaired, she had a vacant stare, complained of headache and loss of vision. A physical examination of

the chest discovered disease also in the lungs. She only had one more fit before her death. *Post-mortem examination*—The ventricles of brain very much distended with clear fluid, septum lucidum broken down, and adjacent parts soft. The principal disease in the brain was a large, strumous mass in the cerebellum, the size of a billiard-ball, round, and having a diameter of little more than an inch. It was firm throughout, of yellow colour, cheesy consistence, and having no structure. It was situated within the medullary structure, and thus, excepting at one part, was entirely surrounded by cineritious substance; at this spot the lower portion was adherent to the dura mater in the cerebellar fossa. The pons varolii and medulla appeared slightly compressed. No tubercles in the membranes. Lungs contained soft, yellow, tuberculous deposit; also lymphatic glands and kidneys. Considerable tuberculous ulceration of the intestine.

Simple acute meningitis.—We have stated that in tubercular meningitis the superior surface of the brain presents but very slight indications of inflammation, while a considerable amount of exudation is found at the base; also that the ventricular effusion is large, and accompanied by softening of the surrounding parts. In this disease, also, the duration of the illness is, on an average, a fortnight, and the symptoms, in the first instance, very obscure. In the form of affection of which we now speak the inflammation is much more acute and more rapid in its progress, as well as being quite distinct in its anatomical characters. Its duration may be only three or four days, and after death the peculiarity consists in the whole surface of brain being covered with lymph. On removing the dura mater the hemispheres may be entirely hidden by the purulent lymph, and which, running in the sulci, may be seen passing down the sides towards the base; at the base, however, often very little is found, and the effusion, we should state, is altogether subarachnoid. The ventricles may show no great change, though sometimes they contain a turbid serum. The substance of the brain presents no visible change, but, as before said, it may, nevertheless, be involved in the inflammation. The contrast between this condition and that found in tubercular meningitis is so striking, that we feel surprised that the two should ever be confounded. It was not our intention in this paper to detail well-known morbid appearances, or the symptoms accompanying them, but merely to portray the characteristic conditions of each. This simple meningitis, we may remark, is much more rare than the tubercular, and its causes also very obscure.

CASE 26.—A little boy, æt. 7, was admitted into the hospital on March 6th. The mother stated that he was well on the morning of the 4th, but during the day became feverish and drowsy; on the 5th he became almost insensible, and on the 6th he was brought to the hospital. He was then in a high state of fever, with quick pulse and contracted pupils. He had no convulsions, but remained in a state of coma until the afternoon of the 7th, when he died. The mother could give no cause for his illness; said he was a delicate boy, and as an infant had had inflammation of the lungs, with convulsions. *Post-mortem examination*—No mark of injury could be found on scalp or bones. On removing the dura mater the whole surface of the brain beneath the arachnoid was seen to be covered with a thick layer of yellow lymph. This was in such abundance that the hemispheres appeared of a light colour, the cortical substance being quite hidden. The sides and base in like manner were covered with the effusion, though to a less amount than in the hemispheres. The inflammatory exudation proceeded downwards to the corpus callosum and between the convolutions, so that sections of the brain showed the lymph existing in large quantities in the pia mater between them. The ventricles contained a slight increase of fluid, and this was opaque and turbid, as if some inflammatory exudation had mixed with it. The whole cerebral substance was soft, and this softness very different from that due to ordinary post-mortem change, for the brain-matter was tenacious and sticky, adhering to the knife and fingers when touched; it was at the same time dry, giving out no watery exudation. This condition of the cerebral substance was seen more markedly in the attempt to tear off the pia mater when it stuck to the latter, so that they could not be clearly separated from each other. The parts forming the ventricles did not appear softer than the rest of the brain. The whole brain was of rather a dark colour, from hyperæmia. A careful examination was made for tubercles, but none were found. All the other organs of the body were perfectly healthy. The lungs also were carefully examined for tubercles, but none were discoverable.

CASE 27.—A child, æt. 3, was brought to the hospital from the workhouse, and no other history could be obtained than that she had been ailing for three weeks. She was then brought merely for advice, but appearing extremely ill, she was taken in. She was in a dull, drowsy condition, resembling that of fever, and it was not quite certain that this was not her complaint. She only lived twenty-four hours, having a severe attack of convulsions shortly before death. On making inquiries as to any injury the child might have received, it was stated that, when fifteen months old, she had a fall and struck her head, but suffered no manifest symptoms in consequence. *Post-mortem examination*—On removing the dura mater, the surface of the brain was seen to be covered with a thick layer of green-coloured lymph; this entered deeply between the convolutions, so that only small portions of the gray matter were here and there apparent amongst the effusion; this was altogether beneath the arachnoid, the surface being quite free. This exudation, which was to a great amount, covered also the sides of the brain and continued round to the base, where it was very slight, the under part of the organ being comparatively unaffected, compared with the surface of the hemispheres. The ventricles contained a slight excess of fluid, and this was clear. The walls of the cavity were natural, not being softer than other parts of the brain, which, as a whole, was rather soft. No tubercles could be discovered in any part. On examining the septum lucidum, fornix, &c., by the microscope, nothing more was found than numerous granules surround-

ing the capillary vessels. The whole of the veins of the brain presented a remarkable condition, from being closed by blood, which had evidently coagulated before death. The smaller veins of pia mater on surface were much distended by clots, the larger branches were in like manner occluded, and the longitudinal sinus itself was completely filled by a firm clot of blood. This was slightly adherent to the walls, and the centre was whitish and soft. The lateral sinuses were in like manner filled, and in these the clot was more broken down and softer than in any other part; the coagulum ceased with the sinus, the jugular vein being quite natural. The bones of the skull were carefully examined, in order to discover if any disease existed in them which could have given rise to the meningitis, but none was found. The temporal bones were healthy, as well as upper cervical vertebræ and other parts. *Lungs*—At lower parts there were many condensed portions of tissue; these were of dark colour, sank in water, airless, and dense; they were at the same time granular when incised, and showed by the microscope exudation-corpuscles. Heart had firm, white clot on right side. The stomach showed post-mortem solution, with contents of the organ in the abdomen. No tubercle discoverable in any part of the body.

We have stated that it is especially in the case of infants who die of convulsions or other cerebral symptoms of a very severe and rapid kind that we are apt to find no morbid appearances in the brain; but in children of a greater age, who have been ill for several days, we are generally in the habit of finding some definite appearance. Such, however, is not always the case. Thus, in the next case to be given, the illness was evidently due to cerebral disease, the symptoms were all cerebral, and death was due to disturbance of the brain, and yet the morbid appearances were scarcely to be marked. The other case is probably more common when death is due to pulmonary or other disorder, but combined with cerebral symptoms, which are found, after death, to be due to some slight inflammatory change.

CASE 28.—A boy, æt. 9½, was admitted under Dr. Rees's care, on November 21st, 1859. A year before he had scarlatina, from which he was ill three months, but had no dropsy. About the same time he met with a severe fall, which lacerated the scalp, and for some months had had a pain in the side. Nine days before admission he began to complain of pain in the head towards the left side, and this was followed by sickness and double vision. On admission he was seen to be an intelligent lad, with a large head. He lay with his head buried in the pillow, avoiding the light, and his brows corrugated. He complained of intense pain in the head, which darted through him like a neuralgia. He had also strabismus, and his vision was double. No sickness; pulse irregular in force and frequency. On the following day the boy appeared better, being less distressed; but on the next day he was worse, constantly turning his head on the pillow, moaning and occasionally screaming out; ceased to answer when interrogated; pupils unequal; pulse 64, slow and

regular; hands convulsively contracted, or limbs stretched out. Thus he was on the following day, uttering fearful cries, moaning, and grinding his teeth. On the 24th he was more feeble; face pale and eyes sunken; lids half open; pupils unequally dilated. He subsequently had general convulsions, which, after some hours, affected the right side only, the left appearing to be paralysed. He then fell into a state of coma, and died on the 25th. *Post-mortem examination*—No mark of injury externally. On removing the dura mater the brain appeared full and large; the arachnoid felt slightly greasy when the finger was passed over it. The cerebral substance was rather a darker colour than usual, from hyperæmia, and also slightly softer. The ventricles contained a slight excess of fluid, and their interior, at the anterior cornua, was slightly granular. Nothing apparent at base of brain or upper part of spinal cord. No tubercles could be discovered. All the other organs in the body were perfectly healthy.

CASE 29.—A boy, æt. 7. Had always been a delicate child. Three years before, he had had measles, after which he took cold, and suffered a long time from ophthalmia. For some years, also, he had had a cough, but no dyspnœa. Three weeks before his death he had a fall, but he did not strike his head; but afterwards his leg became weak, and he was scarcely able to move about, although there was nothing very distinctive the matter. When admitted to the hospital he had a cough, with difficulty of breathing, a high state of fever, severe pain in the head, and strabismus; the child was altogether exceedingly ill. On the following day he was worse; the breathing very difficult; he was throwing his arms about, complained of pain in the head, and uninted, but was quite sensible. His breathing became more and more laborious until he died, but he remained quite sensible until the last. *Post-mortem examination*—On removing the dura mater the arachnoid was found slightly inflamed on the upper surface, as evidenced by a greasiness when the finger was passed over it. This was more manifest at the base, on the under surface of the anterior and middle lobes, where there were distinct granular exudations of lymph, uniting the arachnoid surfaces together. The brain appeared otherwise quite healthy, or at least presented no change appreciable to the naked eye or the microscope. The upper part of the spinal cord was also healthy. The larynx and bronchi were inflamed, especially the smaller tubes, which were filled with mucus. The larynx, and especially the under surface of the epiglottis, was slightly granular, as if chronically inflamed. The left lung adhered to the chest by old cellular tissue. The posterior parts of both lungs were more or less consolidated; this appeared to be in great measure due to mere condensation or an airless condition, and contrasted strongly with the red, spongy portions of the circumference and anterior parts of the lungs; it resembled the carnified lung due to compression, was tough, not lacerable, and gave out only a little mucus from the tubes when squeezed. In the right lung, however, this consolidation appeared to be partly due to inflammatory infiltration, being softer, and on squeezing emitted a red juice and air. There thus appeared a lobular pneumonia, intermixed with the foetal condition. There were no tubercles in the lungs, and all other organs were healthy.

Simple arachnitis.—It is known that the inflammations of the membranes of the brain have been styled by some authors meningitis, and by others arachnitis, according as

they considered the arachnoid or the pia mater the membrane affected. Some also have regarded the terms as synonymous. For our own part, we consider the two affections very different, and of the utmost importance to be distinguished, as having an altogether distinct pathology. We think that the confounding of these two very different conditions has been owing to a mere supposition of their characters by those who have been wanting in practical experience, and we judge so by asking students in what portions of the brain or its membranes do they expect to find the exudation in a case of inflammation, and the reply is generally founded on a knowledge of serous inflammation, as observed in other parts of the body. For instance, a pericarditis, pleuritis, or peritonitis, is evidenced by effusion within the serous sacs, and therefore it is supposed that an inflammation of the coverings of the brain would be shown by an effusion between the arachnoid surfaces. Observation, however, shows that in the latter case the effusion is not between the serous surfaces, but confined almost entirely beneath the visceral arachnoid, or into the subarachnoid space, as it is called, which, in the case of the lung, would be analogous to the lymph being poured out between the pulmonary tissue and the pleura. Now, the explanation of this appears to be extremely simple, although we have never seen it put forth, and it is this: that, in the case of the lungs, heart, liver, &c., when their serous surfaces are inflamed, as in pleuritis, pericarditis, peritonitis, &c., the exudation comes from the blood-vessels situated beneath the serous surfaces, and owing to the serous membrane being stretched tightly over them, this exudation passes immediately through it. Some, of course, is effused beneath, as is well shown in peritonitis of the intestines, where not only the lymph is found on the surface, but an exudation clearly occurs in the subserous tissue, as testified by the facility with which the serous can be separated from the muscular coat. Now, just the same occurs in the brain; in inflammation of its membranes a part of the exudation remains beneath the serous surface and a part passes through, the peculiarity being that, whereas in most serous membranes the exudation passes through, in the present case the lymph remains beneath, a very small portion only being transuded. The cause of this is obvious

from the anatomical arrangement of the cineritious surface of the brain ; instead of this forming a smooth superficies, as in other organs, it is arranged in folds, and between these the pia mater passes ; as, however, the arachnoid does not follow this membrane, but stretches simply across the sulci, all apposition is lost between them ; consequently a considerable space is left beneath the arachnoid, and into this the exudation is poured out. Thus it is in idiopathic meningitis that scarcely a trace of lymph is found on the free surface, the arachnoid presenting merely a greasiness when the finger is passed over it.

There is, however, a condition where the exudation is poured out on the free surface, and is found between the two arachnoids, exactly as it exists in case of pleuritis, pericarditis, &c. As far as our experience reaches, such effusion has its source in the opposite arachnoid, or that lining the dura mater, and consequently has its origin in an affection of the latter membrane. As the dura mater is never or rarely affected, except secondarily to the bone, it follows that this arachnitis is due to disease or injury of the cranium. We therefore speak of arachnitis as an inflammation resembling the inflammation of other serous membranes, where the exudation is inter-serous, while by meningitis we mean an idiopathic inflammation shown by a subarachnoid exudation. We have never yet met with a case of the former kind which did not depend on affection of the bone, and in most cases on injury. We therefore feel justified in speaking of it as a distinct form of disease, and arising from a specific cause. We should state that the exudation between the serous surfaces does not preclude the existence of an exudation beneath the arachnoid, and, indeed, in a case of fracture of the skull, with injury to the brain, the probabilities are that both forms of inflammation would be combined.

CASE 30.—A boy, æt. 11, was run over, and brought to hospital with large scalp wound. He was throughout in a listless, half-conscious state, and at last sank into a state of coma, and died at the end of six days. On *post-mortem examination*, the cranium was found fractured on left side, and a small portion of bone had penetrated the dura mater, producing a small hole about the size of an ordinary lead pencil. On removing this membrane acute arachnitis was found to have occurred, whereby the arachnoid surface covering the left hemisphere, as well as the corresponding mem-

brane on dura mater, were covered with a purulent lymph. On the right side the inflammation was slight, and a little lymph was found at the base.

CASE 31.—A boy, æt. 7, had a poker thrown at his head; the point struck the left side of his head, producing a small hole. No marked disturbance attended the injury, but soon afterwards cerebral symptoms came on, and he was admitted two days after the receipt of the accident. He was then evidently suffering from arachnitis, being in a feverish state, drowsy, and occasionally shrieking out. A small piece of bone was removed, corresponding to the spot which received the blow. The symptoms continued, and he died five days afterwards. *Post-mortem examination*—On the left side of the head was a small opening, through which a probe could pass, and in the corresponding dura mater also. On turning back the latter the most acute arachnitis was seen, the purulent effusion being in so great abundance that it poured down on the ground in a stream. The inflammation had extended all over the brain, but was more on the left side, the inner surface of dura mater being coated with a thick layer of soft lymph. On washing off the effusion from the free arachnoid, there was found also to be some inflammatory exudation in the subarachnoid space, though this was comparatively little. This, however, was seen to pass down in the course of some of the pia-mater-vessels, along the sides of the brain. The brain opposite the fractured bone was slightly contused.

Convulsions.—We have already said that convulsions terminate fatally without any explanation being discoverable in the brain, and can only be attributable to a general molecular change, such as we suppose produces a fatal result in chorea, epilepsy, &c.

CASE 32.—A little child, æt. 6 weeks, was admitted into the hospital for the purpose of having an operation performed on a hare-lip. He was a small, delicate child, and living on his mother, who took charge of him. While awaiting the day for the operation he was seized with diarrhœa and violent convulsions, and in a few hours died. A *post-mortem examination* was made, and the brain carefully examined, but nothing unnatural could be perceived about the membranes, cerebral substance, ventricles, or any other part. All the other organs throughout the body were also healthy; no tubercle in any part. The mucous membrane of intestine healthy, and its glandular apparatus.

CASE 33.—A boy, æt. 4, was brought into the hospital with convulsions, and shortly afterwards died. He was a strong, healthy-looking child, and had had no previous illness. The body was carefully examined, and first of all the brain, but it appeared perfectly healthy. Lungs healthy. Right side of heart distended with fluid blood. The thymus gland was of good size, but not morbidly large. The peritoneum was much injected from hyperæmia of the capillaries. The stomach was much distended with recently taken food, amounting to a pound and a half, the principal part of which was potato. Kidneys quite healthy, as well as other organs.

CASE 34.—Quite lately, Dr. Whitley requested us to accompany him to make a post-mortem examination on a child who had died of convulsions. The mother was aged twenty-five, a dissolute woman before her marriage, and subject to epileptic fits. She had had four or five children, all of whom had died suddenly of convulsions when less than six months old. The last child was quite well until two days before

its death, when it was seized with convulsions, which speedily terminated fatally. The body was that of a well-grown, healthy looking child. The brain was carefully examined, but no morbid change whatever could be discovered.

Chronic hydrocephalus.—Just as the acute affections of the brain have been classed by some under one head, and yet we think can be fairly separated into certain divisions, so it is possible, we consider, to make some distinctions in the disease which has generally been spoken of as chronic hydrocephalus. We should state that our remarks are confined to cases of ventricular effusion, as we know nothing of the disease styled external hydrocephalus. There can be little doubt that various pathological conditions exist under this term, and that every case where the head is enlarged, and that many where an increased amount of fluid is found after death, have received this designation. In many cases nothing is discovered after death but the effusion in the ventricles, and we are, therefore, bound to suppose that this is due to some morbid condition of their surface which is inappreciable to our senses. The effusion in such case is altogether comparable to what sometimes occurs in the chest or tunica vaginalis, where the serous membrane has become temporarily at fault. In some cases the interior of the ventricles has presented a slightly granular appearance, indicative of an inflammatory change. That a ventricular effusion may be due to a simple exudation, is clear from the fact of its being so readily again absorbed, as is witnessed sometimes in children. We know, for instance, the case of a little child, where during an illness the head became considerably enlarged, but subsequently declined to its original size. When we speak of chronic hydrocephalus, we should confine the term to this simple effusion.

Effusion may occur as a result of other morbid changes, both in the child and in the adult ; as, for example, where tumours have been slowly growing. As, however, the head cannot enlarge when the bones are consolidated, there is no likelihood of the term hydrocephalus being applied in the latter case, but the contrary is the fact in the case of infants, where ossification is not yet complete. Thus it is that we have seen the term at several times applied to instances of effusion due to large, tuberculous masses in the brain. One of these we will detail, but two other similar ones we have seen.

There is still a third affection, which can with propriety be separated from these, in which the head is not necessarily enlarged, and is fatal only after a lengthened period, or even in adult life. It is probable that these cases have arisen from some acute affection in childhood, and that from the severe change then occurring the brain and its functions are never perfectly restored; consequently, a dulness of mind or idiocy may result, and after death a ventricular effusion be found. It has been long considered by Mr. Hilton,¹ that the effusion might be due to a closure of the fourth ventricle below the cerebellum, and so the fluid prevented passing down the sub-arachnoid space in the spine. In the first case to be mentioned the hydrocephalus appeared due to some recent morbid state, but the remaining two cases form examples of the disease alluded to, probably having its origin in infancy.

CASE 35.—A young man, æt. 17. Was said to have been ill some weeks with typhus fever, and that afterwards his head became affected. On admission he was exceedingly ill, and evidently suffering from cerebral symptoms. He lay on his side, coiled up in bed, sensible, but complaining severely of his head. On following day he died. His body was much wasted, as of one long ill, and abdomen contracted. On opening the head and removing the dura mater, the surface of the brain was seen to be much flattened, and the sulci almost obliterated, except a slight greasiness on the hemispheres. No effusion of lymph was seen anywhere on the surface, either above or at the base, and on stripping off the pia mater no tubercles were discoverable. The ventricles were much distended with fluid, containing between three and four ounces. This was clear, slightly more opaque than healthy serum on boiling, and its specific gravity 1010. The foramen of Monro was very large, septum lucidum thin, but none of these parts at all soft. The iter a tertio large, and fourth ventricle much distended. The surface of all the cavities was granular. The arachnoid at base of brain was thick and partially adherent; and although this was not positively made out, it appeared to offer an impediment to the flow of fluid from the fourth ventricle. The pons and medulla oblongata were flattened and compressed by the central effusion. The substance of the brain appeared to be everywhere healthy. All other parts of the body quite healthy.

CASE 36.—A young man, æt. 20. Had all his life suffered with his head, having occasional pain, oppression, and at times appearing as if his mind was enfeebled. During four months all these symptoms increased, and at last assumed more of an inflammatory character. After death, the only morbid appearance discoverable was an immense effusion into the ventricles. There was no opportunity of measuring it, but the quantity was thought to equal a pint.

CASE 37.—The details of this case are mislaid. It was that of a gentleman at whose necropsy we were requested by Mr. Hilton to assist. He was about forty

¹ 'Lectures by Professor Hilton, at the Royal College of Surgeons.'

years of age, and since childhood his mind was of that weak character that although he was able to amuse himself by various occupations, he was not equal to business. He also somewhat faltered in his speech, and had various other symptoms denoting an impaired state of brain. One day, after having been enjoying himself at the Crystal Palace, he returned home, and died quite suddenly. The only post-mortem appearances discoverable were a large collection of fluid in the ventricles of the brain. The arachnoid at the base was thickened and opaque, and it was the opinion of Mr. Hilton that some obstruction to the lower opening of the fourth ventricle had been caused thereby.¹

Secondary ventricular effusion.—The following case will be clearly seen, on perusal, to afford evidence of other disease besides that of ventricular effusion, but during its progress it was often styled one of hydrocephalus, from the large size of the child's head. A very similar case we have lately heard of, where a child, long under our notice for enlargement of the head, was found after death to have a large, scrofulous tumour at the base. It may be that the effusion is caused simply by pressure on the veins of Galen, such as occurs from venous obstruction elsewhere. It is worthy of remark how this child was in the habit of boring with the back of its head into the pillow, until the hair was completely worn off, a circumstance to be noticed in all head affections of children. Another point of interest, though not clearly explicable, is the discharge of serum from the ear; this was passed over without any especial regard, but our notice has since been directed to the fact in the case of a child who died with somewhat similar disease, and from whose ear a large quantity of fluid ran into the coffin after his death. There was no post-mortem examination to elucidate the occurrence.

CASE 38.—Boy, æt. 4, of whom the mother gave the following account: That fifteen months before the time he was first seen he had an attack of measles, and that soon afterwards the abdomen swelled. In six months' time the abdomen decreased in size, and then the head became affected; it grew large, and there was an alteration in the boy's manner; he was slow, and hesitated in answering; after this he began to lose power in his left side. When first seen he was scarcely in a sensible condition; he lay in bed, unable to lift up his head, which was very large,

¹ From the description given of the post-mortem examination of the boy who was alleged to have died at Eastbourne after flogging, it would appear that the case was very like those we have mentioned, exemplified by the low mental development from childhood, and the only marked post-mortem appearance a ventricular effusion.

and he often applied his right hand to it; pupils dilated. At the end of the month his state was much the same, but the left side was completely paralysed, the pupils were dilated, and the child, judging from his vacant stare, appeared quite blind. In the night he often screamed and started. Afterwards a watery discharge was observed flowing from the ear. Subsequently the other side of the body became paralysed, as well as the rectum and bladder. The child often had violent fits of screaming, but never any convulsions. He lived six months after he was first seen, and nearly two years from date of first illness. *Post-mortem examination*—There was a bed-sore on the sacrum; the head was as large as that of a child of ten years, and from the occiput the hair was rubbed off, and an ulcer existed. The fontanelles were not closed; the surface of brain healthy, but hemispheres burst open from the weight of the fluid within. This could not all be collected, but was reckoned to amount to a pint; it was clear, like water. The ventricles were thus of enormous size; the septum lucidum was entire, but like a piece of tissue-paper, and the corpus callosum much resembled it. The ependyma were not softened, as in the white softening of acute disease. On attempting to remove the brain, the cerebellum was found adherent to the dura mater, owing to the presence of two scrofulous tubercles in the cerebellum; one was very large, the size of a small egg, and to this was attached a smaller one; the larger one was two inches long and one inch broad; the right lobe of cerebellum was thus destroyed, and neighbouring parts pressed upon. The mesenteric and other lymphatic glands contained tuberculous deposit; also lungs, liver, kidney, and spleen.

Simple ventricular effusion, from anæmia.—We have already alluded to a supposed form of head disease which is due merely to exhaustion, and described by Dr. Gooch and Marshall Hall. The following appears to be an example:

CASE 39.—A little girl, æt. 17 months, whose case is mentioned hereafter as one of poisoning by sulphuric acid. Had, at the time of the accident, been suffering from symptoms which were attributed to the brain. On *post-mortem examination*, besides the discovery of the appearances in the stomach due to the poison, the brain was in an unhealthy condition, and presenting the appearances which might be considered to be those of chronic hydrocephalus. The whole structure of the brain was soft, but especially the parts surrounding the ventricles, and which were distended with three or four times as much fluid as is natural. This protruded the infundibulum below into a thin, membranous sac. No tubercles discoverable. No tubercle in any part of the body.

Hydatids in the brain.—These must be extremely rare, for during the last fifteen years no single case has occurred at Guy's Hospital. The following case of cysticercus occurred in our dispensary practice, but we place it here to show how obscure during life are, very often, the cerebral affections of children. In this case we are not at all prepared to say how far the symptoms depended wholly on the presence of the

parasites, or whether any other morbid condition of brain existed, though unappreciable to the eye.

CASE 40.—A boy, æt. 6½ years. Was visited at home, and found lying insensible in bed, with sordes on mouth, and scarcely able to swallow. A medical man, previously in attendance, had called the case one of fever, and had administered stimulants. The mother stated that on that day fortnight the child was quite well, when he fell out of a cart on to his head. He was much frightened, and in the night was continually talking of the accident. On the following days severe febrile symptoms existed, with delirium, &c., at night. The blow on the head was not severe, and neither the mother nor doctor attributed any consequence to it. When seen at the time above mentioned, his pupils were natural, abdomen flat; he was scarcely conscious, but continually raised his head from the pillow, and threw it back again; respiration sighing and irregular. On the second day of visit the boy was quite unconscious, and pupils dilated, with eyes fixed, very restless, continually raising his head from pillow and throwing his arms across his head and back again. During the next four days of his life he had continued in much the same state, semi-conscious, pupils rather dilated, his extremities continually stretched out, but no regular convulsions. *Post-mortem examination*—Surface of brain healthy; no trace of lymph, either on hemispheres or at base. On the left side, opposite the temporal bone, a bunch of cysts were seen slightly attached to the surface by a little cellular tissue, and so little adherent that they fell off to the ground; the arachnoid at this spot was slightly opaque. No tubercles were discoverable in any part of the brain; there was no increased effusion into the ventricles, no lymph at the base, and all parts of the cerebral structure firm; indeed, apparently firmer than usual. The cysts were examined, and found to be cysticerci, the hooklets well displayed and one of the parasites containing a considerable white deposit of chalky matter.

CROUP, LARYNGEAL AFFECTIONS, AND TRACHEOTOMY.

Croup.—Opinions still vary as to the exact definition of croup; the typical case is allowed by all to be that where a membranous exudation takes place into the larynx and trachea, but it is still a question whether an affection characterised by all the symptoms of croup should be excluded from the appellation because the exudation is aplastic; or that nothing less than the discovery of a false membrane will warrant the application of the term. As it is quite the exception to witness the expectoration of this membrane, since it is disintegrated in the air-tubes, it would require, in most cases, a post-mortem examination in order to determine the nature of the disease. Even then, should it be found absent, the practitioner would not be willing to withdraw his diagnosis if all the evidence has been present during life of

an acute inflammation of the trachea. This has given rise to a division of croup into the membranous and catarrhal forms. This difficulty in its definition strikes at once at the pathology of the disease, and suggests an inquiry into the correctness of the generally received opinion, that an inflammation of the larynx and trachea, accompanied by a membranous exudation, is a peculiar pathological condition, and therefore to be distinguished from an inflammation with the ordinary products. Should such two different affections be found after death, and distinguished by their own peculiar symptoms during life, there would be no hesitation in separating them. Even, indeed, were there no marked difference to be observed in the symptoms, but only such a distinction as is shown by the presence or absence of a false membrane on post-mortem examination, this even might be considered a sufficient ground on which to found a distinction. If, however, on the other hand, we discover, after death, the membranous and the catarrhal forms passing into one another, or in fact mixed, it would tend to show that the affections were identical. The tendency of our own opinion is to the latter theory, and for many reasons. We think that the membranous exudation is due, not so much to any pathological peculiarity of the disease as to the anatomical structure of the air-tubes in children, and that this form of exudation need not of necessity occur, though the disposition exists always to its formation. We judge so from the fact that similar membrane is produced by any accidental irritation of the mucous surface, such as occurs in children from the swallowing of boiling water, some instances of which we will give. We think, also, that it is quite impossible to discover during lifetime, in cases of laryngitis and tracheitis, whether a false membrane exists or not, since the swelling of the mucous membrane is sufficient to create all the symptoms. We know that, as a rule, in cases of croup there is no proof of the existence of a false membrane, and that in many cases where there has been no hesitation in giving this name none has been found after death. We would, then, state our opinion in these few words:—that if, from cold, children get inflammation of the chest, that the disposition for this to affect the substance of the lung, that is, the air-vesicles, is much less than in the adult, but that the air-passages are more liable to be affected,

and the larger tubes rather than the smaller. Thus it is that not only bronchitis, but tracheitis and laryngitis, are so frequent; and, moreover, from the anatomical structure of these parts, the exudation is commonly of the membranous kind. In most cases of inflammation in children we believe the whole air-passages are affected, in bronchitis the larger tube but slightly, while in croup the smaller tubes less frequently; in fatal cases, however, these are generally found involved, and we would here say that it is certainly incorrect to confine the term croup to the trachea, as the terms tracheitis or cynanche trachealis would imply, since in every case that has fallen under our notice the larynx has been equally involved; we believe, also, the difficulty of breathing has been due as much to the obstruction at the glottis as to the presence of a false membrane in the trachea.

Tracheotomy.—We do not intend to refer to this subject in connection with the treatment of croup, since we have not sufficient data from which to form an opinion, but rather to allude to some points which bear on the operation generally. We think there is an advantage in this, for the operation may be regarded in different aspects when had recourse to in different diseases; thus, for example, in croup the simple effects of the operation cannot be distinguished from the effects of the disease, and the former may be attributed to the latter, and thus no heed taken at all of the hazard attending the opening of the trachea. It is to this point we especially wish to draw attention, as it seems to be altogether passed unnoticed by the writers on croup, our own opinion being that tracheotomy is an operation attended with a considerable amount of danger, and therefore not to be lightly spoken of as a simple expedient of opening the trachea for the purpose of making a new passage for the air. Of course we have nothing to urge against its adoption when considered necessary, but have much to say in opposition to the opinion that tracheotomy can do no harm, and that the operation is a harmless one. We believe it to be one of considerable hazard, and not to be put in practice without deliberate reason for its necessity. Such a conclusion can scarcely be arrived at by the consideration of cases of croup only, but rather from the effects produced on the healthy trachea. In cases also of laryngitis or œdema glottidis, pro-

duced by swallowing boiling water, where the operation has been performed and considerable inflammation has been found, it would also be difficult to draw an inference as to the proportional influence of each cause; but where, from a local and chronic disease of the larynx, an acute inflammation has followed tracheotomy, there can be no hesitation in attributing this to the operation. So, also, in cases where a foreign body has been so speedily ejected after the operation as not to have allowed time to produce any injurious effect, but yet death has resulted from tracheitis succeeding the opening of the tube. We might also allude to cases of cut throat, where it is not unusual for the immediate cause of death to be due to acute inflammation of the air-tubes. In considering this subject, we have been much pleased in reading a paper by Dr. Bevan, in the 'Dublin Quarterly Journal,' on the treatment of scalds by boiling water, and the great success of antimonial medicines, and with the same view we have heard advocated the operation of puncturing the swollen glottis. Any or all of such means, we feel sure, should be adopted before tracheotomy is had recourse to; but without speaking of treatment, we would wish to confine attention to this simple point—the danger attending tracheotomy, and we do so because we have often put the question to surgeons regarding it, and have most frequently received the answer that it is an operation attended with no danger. We think that it has been too much the rule to consider it in this light, but for our own part we are not surprised at the fearful mortality which attends the operation in children, when had recourse to for such accidents as we have named. Death generally occurs a few days afterwards, from inflammation of the air-passages, and this can occasion no surprise when we consider that, in addition to the cause which has necessitated the operation, the latter comes in to increase the irritation; thirdly, the cold air taken in through the artificial opening tends to further excite the mucous membrane, and then, as is often the case, chloroform is administered. This may possibly act as a fourth source of irritation. There can be no wonder, then, in the contemplation of the result, that out of fourteen cases published in the 'Medical Times' only three recovered.

We believe there is another source of danger in tracheotomy, but as we have never seen this alluded to by authors, we would

speaking of it with some hesitation, from our small data. We refer to pneumo-thorax arising from the escape of air from the mediastinum having been drawn into the chest from the neck. That air may be drawn in around the wound is clear, from a case of general emphysema arising therefrom, which we shall presently relate.

We will now give a few cases to illustrate our remarks. The first three show how in croup the affection is not confined to the trachea, but that the false membrane extends over the whole larynx, as high as the glottis, and at this part is to be sought especially the source of the alarming choking symptoms and ringing respiration. They also show that in fatal cases the bronchial tubes are likewise affected; in fact, that in croup the whole air-passages are involved, though no doubt the bronchi but slightly so, in the cases which recover. We should say, also, that apart from diphtheria, the pharynx and parts immediately external to the epiglottis are also inflamed. In the two cases which follow these, tracheotomy was performed, and these show how impossible it is in such to form any conclusion as to the immediate effects of the operation on the air-tubes when they are previously diseased, and therefore how easy it is to depart from the inspection of such a case and never have any thought as to the hazard of the operation. In the first of these cases, however, a source of danger is clearly seen in the fact of the false membrane becoming detached and blocking up the trachea. In this case the separation was at the entrance of the canula; the instrument had torn through the membrane, which subsequently falling, caused the child's instant death.

We may here take the opportunity of saying, that in no case have we found any clot in the heart which could be called ante-mortem, or of that kind which could be said to contribute to the fatal result. All we have discovered is a firm clot in the right auricle and ventricle; that in the latter sometimes sending its branches into the pulmonary artery throughout the lung, but not at all differing in character from what may often be met with in pulmonary apoplexy, pneumonia, or bronchitis, when the blood has been much retarded from causes originating in the lungs themselves.

Cases of croup.

CASE 41.—A little boy, æt. 2½ years, was admitted into the hospital, dying with croup, and survived only a few hours. The *post-mortem examination* showed a perfect membranous cast lining the larynx and trachea, extending from the glottis as low as the bifurcation; the tubes throughout the lungs filled with a creamy mucus; extreme lobular congestion throughout the tissue, but no actual pneumonia. The mucous membrane beneath the lymph-cast pale. The heart contained a small amount of fibrinous clot on right side.

CASE 42.—A little girl, æt. 10, was in the hospital for disease of the hip-joint; she also had albuminuria. She was one day, while in bed, suddenly seized with croup and quickly died. On *post-mortem examination*, the larynx and trachea, from the vocal cords as far as the bifurcation, were covered with a firm layer of lymph, forming a false membrane; at the bronchi this gradually became softer, and terminated in a muco-purulent secretion which filled the remainder of the air-passages. The lung tissue healthy. There was a slight diphtheritic inflammation of the large intestine; the liver was lardaceous, and the kidneys were in a state of albuminous nephritis. Nothing remarkable in heart.

CASE 43.—A little boy, æt. 4, was said to have had sore-throat and difficulty of swallowing for three weeks, when the breathing became affected and all the symptoms of croup supervened, the child dying in three days. The *post-mortem examination* showed the tonsils to be swollen and throat covered with flakes of secretion, though with no actual membrane; the epiglottis and glottis were much swollen. The whole of the larynx and trachea covered with a complete cast; at the bifurcation this passed into a thick, purulent secretion, which was continued into the minutest branches. The mucous membrane itself of a bright-pink colour. The lungs were gorged with blood; at the apex of one there was a consolidated portion of lung, which on section was seen to consist of numerous hepatized lobules. Nothing noticeable in heart.

CASE 44.—A little girl, æt. 6. She had lived in a house where scarlet fever was said to exist, and she herself had had a sore throat; she had, however, no eruption, nor was ill enough to keep her bed. Ten days before her death she caught cold, followed by cough and a noisy respiration. These symptoms continued for five days, when she became rapidly worse; on the following day, when first seen she had all the symptoms of croup, though not to an alarming extent. The right side of the chest superiorly was dull on percussion, with absence of respiration; on the next day, the breathing having become worse, tracheotomy was performed; there was immediate relief to the symptoms, and the child continued for the next three days in a good condition, when she suddenly died; so sudden, indeed, that it was thought some obstruction had occurred in the canula. *Post-mortem examination* showed acute croupous inflammation of the air-passages; the membrane commenced on the under surface of the epiglottis and continued downwards, as a firm cast, as far as the bronchi, where it passed into a purulent mucus; and this was found in the extreme tubules of the lung. On the epiglottis the false membrane was so firmly attached that it could with difficulty be removed, while below it could be detached as a hollow tube. At the point of entrance of the canula it had been torn away and turned downwards by the instrument, and thus the trachea was quite filled by it.

As the respiration had been easy until just before death, it is most probable that the membrane fell down at that time, and suddenly choked the child. The right upper lobe of lung was adherent to the chest by recent lymph, and the whole lobe was consolidated, being in a state of gray hepatization as in the adult. The remainder of tissue healthy. A few tubercles found in lungs and in bronchial glands. Nothing remarkable in heart.

CASE 45.—A little girl, æt. 4; when first seen had been ill two days with croup. Tracheotomy was immediately performed; relief followed, and the child appeared doing well until shortly before death, when the breathing became more laboured and death rapidly ensued. The *post-mortem examination* showed the throat to be quite healthy, and external surface of epiglottis, but internally a false membrane was found extending from the latter to lower end of trachea; the under surface of the epiglottis was covered with a false membrane, but this hung in shreds to the trachea, so that there did not exist a perfect cast. This membrane was remarkably adherent, and some force was required to remove it; at the bifurcation there was a loose piece of detached membrane; the tubes, to their extreme termination, were filled with a purulent mucus. The posterior parts of lungs were airless, due in part to collapse of some lobules, and inflammatory exudation in others.

We will next briefly relate two cases, for the purpose of showing how, from the obstruction in the air-passages, all inflammatory diseases of these parts are liable to be styled croup.

Laryngitis.

CASE 46.—A little girl, æt. 15 months, had had cough for some time, and was said to have had croup three months before death; and four days before death the symptoms came on again, and when seen, shortly before her decease, the complaint, from the severe laryngeal distress, appeared to be of this nature. The *post-mortem examination* showed the larynx to be œdematous; the laryngeal mucous membrane was granular, and on its surface minute points of exudation; the mucous membrane pink; that of trachea was pale; the bronchi full of purulent fluid. There were also one or two aphthous ulcers on the edge of the epiglottis. The heart contained a post-mortem clot on the right side. Brain healthy.

CASE 47.—A boy, æt. 5, was in the hospital for chorea, when he was taken ill with a fever, which appeared to be measles; and died with bronchitis, accompanied with croupy respiration, a week after the first onset of the symptoms. The *post-mortem examination* showed the glottis to be acutely inflamed, the edges being of a scarlet colour and much swollen; there were also one or two points of minute ulceration. The mucous membrane of the larynx, trachea, and bronchial tubes intensely injected from a hyperæmic condition of the blood-vessels. The whole of the air-passages also covered with a very tenacious purulent mucus. Brain healthy. Heart, minute vegetations on mitral valve; right side distended with blood, mostly fluid.

Effects of tracheotomy.—We will now relate some cases

where tracheotomy was performed, either to facilitate the escape of a foreign body, or to allow the entrance of air in closure of the glottis; and in some of these cases, although the operation was no doubt warranted, we cannot but consider it as the cause of the fatal inflammation. In some instances this would appear to arise, not so much from the primary wound as from the secondary suppuration around it; and in these the unhealthy character of the inflammation is liable to extend even to the lung tissue itself, there producing a sloughing form of pneumonia. In the first case next to be mentioned, it cannot be supposed that the piece of nutshell, which was so shortly dislodged from the windpipe, could have but a very comparatively small share in the production of the inflammation, and which must, therefore, be attributable to the operation. We must not be mistaken in the supposition, that we are advocating any other treatment in so perilous an accident, but that we are merely drawing attention to the fact of its importance and hazardous results. In the second case, there could be no doubt whatever as to the operation being the cause of death, for it will be seen that suppuration had extended from around the trachea down the mediastinum. In the third case, the operation was inevitable, in order to save the child's life; but here, as death was more speedy, there may be a question as to the proportional influence of the disease and its remedy in the fatal result. The case after this is very interesting, as exemplifying the tendency to croupous inflammation in children, as well as the collapse of the lung from the closure of the bronchus; the suppuration in the mediastinum, resulting from the operation, should also be noted.

CASE 48.—A little boy, æt. 14 months, was found by its mother choking, and she, not being able to afford him any relief, brought him to the hospital. Tracheotomy was performed, and very soon the child coughed up a piece of nutshell. He did well for three days, when the breathing became difficult, and much purulent discharge took place from the wound; the pulmonary symptoms continued, and the child at last died rather more than a week after the occurrence. *Post-mortem examination* showed the air-passages to be inflamed and covered with a creamy, purulent secretion, the larynx and trachea above the wound being much less affected than the parts below. The posterior parts of both lungs consolidated by inflammation; the hepatization being irregular, certain lobules showing perfect consolidation, while the intervening tissue was more recently affected.

CASE 49.—A little girl, æt. 3½, drank boiling water from a tea-kettle, and was

brought to the hospital eight hours afterwards. The dyspnoea was so urgent, and death apparently so near, that tracheotomy was immediately performed; the relief was instant, and the child continued to progress for some days, and was able to speak when the artificial opening was closed. On the ninth day the wound appeared unhealthy, and suppuration commenced around it; at the same time, the breathing became quick, and much mucus was thrown out. During the following four days the pulmonary symptoms increased, when death took place. The *post-mortem examination* showed the suppuration around the wound to be very extensive, proceeding backwards and downwards along the œsophagus to the posterior mediastinum, and in front around the thymus gland. The pharynx had two small ulcers on its surface; the œsophagus was healthy. The larynx showed the edges of the glottis swollen and thickened; the mucous membrane was ulcerated, and in many parts hung in loose shreds. The trachea and bronchi were completely filled with tenacious purulent mucus, and some of them had also complete lymph casts. The mucous membrane was highly vascular. Both lungs were more or less affected by lobular pneumonia, and on both sides was acute pleurisy.

CASE 50.—A little boy, æt. 1½, drank from a boiling tea-kettle in the evening. No ill effects were thought to have ensued; but in the course of the night difficulty of breathing came on, and on the following morning he was taken to the hospital, where tracheotomy was performed, the child being then moribund. Instant relief ensued, and he progressed favorably for the next two days, when the breathing became hurried, and this gradually increased for another two days, when death took place. The *post-mortem examination* showed the tongue to be slightly excoriated; the epiglottis and glottis were both swollen, but not to any great extent, so as to produce closure. The whole of the air-tubes were inflamed and filled with secretion; that on the trachea could be taken off in films, but below the secretion was fluid; the inflammation was most intense below the artificial opening, but above, the larynx was but slightly affected. There was slight pleurisy on the right side. A considerable portion of lower lobes, as well as parts of upper, were consolidated by diffused lobular inflammation.

CASE 51.¹—A little boy, æt. 3, whilst playing with a French bean in his mouth, drew it into the windpipe, no very urgent symptoms immediately followed. After some hours, however, the dyspnoea becoming urgent, the child was taken to the hospital, when tracheotomy was performed by Mr. Forster, but without any good result, as it was evident from the absence of respiratory murmur in the right side that the bean had stuck in the bronchus; the breathing became more and more difficult, until death took place three days from the time of the accident. The *post-mortem examination* showed the right lung to be collapsed; the cellular tissue in anterior mediastinum contained some inflammatory exudation. The whole of the air-passages acutely inflamed, and glottis swollen. The interior of larynx and trachea covered with a membranous lymph, as in croup, but not so tenacious or perfect; the tubes filled with mucus. In the right bronchus the bean was firmly impacted, and so swollen that it was not possible to extract it by the glottis; the tissue of lung airless and firm.

We will now relate two cases of œdema glottidis as the result of accidental causes, for the purpose of showing that we

¹ This case has already been published in the 'Med. Times and Gazette.'

have no wish to maintain that such an affection is not highly dangerous, and often fatal, however produced; but they will also show that, where the operation was not performed, there was no acute inflammation of the trachea or bronchial tubes.

CASE 52.—A little boy, æt. 1½, drank from a cup a mouthful of soap lees. Some oil and mucilaginous drinks were administered, and in about two hours some difficulty of breathing came on; this, however, did not become very urgent until just before death, when there was present a very pungent heat of skin. The child died twelve hours after swallowing the fluid. *Post-mortem examination*.—The mouth and tongue slightly excoriated, and of a light-brown colour; the throat also presented the same appearance. The whole of the œsophagus presented a similar condition, the mucous membrane being of a brownish hue; at the very extremity of the tube, however, it was very dark brown, but this terminated abruptly at the stomach; near the pyloric end of this organ was a brown patch, showing that the alkali had entered it. The glottis was quite closed from inflammatory œdema. The mucous membrane below healthy, as well as that of remainder of air-passages; but tubes filled with mucus. The lower lobe of left lung was almost airless, due to a collapse of some lobules, and to an exudation in others.

CASE 53.—A little girl, æt. 3½ years, drank some boiling water at five o'clock in the afternoon; soon some difficulty of breathing came on, and this increasing, she was brought to the hospital at ten; the dyspnoea did not appear then to be sufficiently urgent to necessitate an operation, but the child very soon afterwards quite unexpectedly died. The *post-mortem examination* showed the back part of the throat and epiglottis to have been scalded—of a white colour, and some loose shreds of epithelium. The glottis œdematous, and closed by inflammatory serous infiltration. The bronchial tubes contained frothy mucus, and were congested.

We have hinted at the possibility of *chloroform* being an additional excitant to the lung; we have very little proof of this being the case, having, indeed, only seen one instance where the fatal result could by mere suggestion be attributable to such a cause. It might, therefore, be regarded as the exception which proves a contrary rule. The case is as follows:

CASE 54.—A little boy, æt. 2, was cut for stone in the middle of the day, on the 13th of March, having then no pulmonary symptoms. Chloroform was administered as usual, and the operation was speedily performed. About two hours afterwards his breathing was observed to be difficult, and in the evening he had all the symptoms of bronchitis. The child got rapidly worse during the following day; and on the third day died, exactly forty-eight hours after the operation. The appearance of the body was that of a healthy child; the incision for the operation was quite correct, and there was nothing about the wound more than ordinary. Death was evidently due to the lungs; the whole of the air-passages were acutely inflamed. The mucous membrane of larynx, trachea, and bronchi of a bright-red colour from vascular injection; also slightly granular upon the surface, and soft and swollen; the glottis

and epiglottis participated in the inflammation. The tubes were the parts most affected, the mucous membrane being swollen, red, and velvety, and the whole of their branches throughout the lungs being filled with a tenacious purulent mucus. Pulmonary tissue healthy. Heart contained a very firm, white, fibrinous clot on the right side, and much distending the auricle.

Emphysema after tracheotomy.—We have said that we have never heard of emphysema being spoken of as an accident of tracheotomy, but that it does occur is seen in the following cases. In the first two it was confined to the chest, but in the third it was universal. On the post-mortem examination of all these cases, the possibility of the rupture of an air-bubble producing pneumothorax was forcibly suggested to our mind, but in none could the fact be proved.

CASE 55.—A girl, æt. 11 months, was suddenly choked while drinking some broth. She was brought to the hospital, having considerable dyspnœa, and with a crowing sound, indicating laryngeal obstruction. The trachea was opened, with immediate relief to the patient. After four hours, however, the breathing became more difficult and rapid, and the child quickly died. On *post-mortem examination*, a piece of bone was found sticking fast in the rima glottidis, the opening below being quite free; the bronchial tubes were healthy, the lungs collapsed. In the anterior mediastinum, emphysema existed to a great extent, being full of bubbles of air, and the thymus surrounded with air in the same manner. It was not proved that any of these air-vesicles had burst into the chest.

CASE 56.—A girl, æt. 3, admitted into the hospital for a piece of nutshell in the trachea, and which was producing alarming symptoms of suffocation. Tracheotomy was performed, in the hope that the foreign body would be coughed up; this, however, was not the case, but shortly the breathing became difficult, and the child died in a few hours. *Post-mortem examination*:—The piece of nutshell was found sticking in the rima glottidis. The mucous membrane of the whole of the air-passages was inflamed, and covered with secretion. The left lung was collapsed, the right adherent from old disease. The cellular tissue in the mediastinum was full of air, from emphysema. Some of the bullæ of air were very large, and a slight pressure enabled the finger to burst them into the chest.

CASE 57.—A woman, æt. 33, was admitted under our care for chronic laryngitis, probably of a syphilitic character. At night she appeared to be dying from obstruction, and tracheotomy was therefore performed. A general emphysema immediately ensued, and rapidly spread over the whole body; the neck, chest, and arms being immensely distended. On the following day she died, the dyspnœa being still very great. The *post-mortem examination* showed the glottis quite closed by a tough fibrous deposit in its tissue. The operation was perfect: there was a slight scratch on the mucous membrane opposite to the entrance of the trocar, but no passage through which air could have entered; indeed, no way into the cellular tissue, except by the side of the canula. Both lungs collapsed against spine, and airless; the cellular tissue both of anterior and posterior mediastinum was

highly emphysematous. Cervical glands slightly enlarged. Fibroid deposits in the liver.

Inflammation of trachea, from injury to it.—We have said that it is impossible to recognise the immediate effects of tracheotomy on the air-tubes if they be previously diseased, and therefore it is necessary to examine those instances where these parts are healthy previous to the operation. On consideration of such, we cannot but come to the conclusion that, notwithstanding the necessity of the operation, death is often due to it. We take, for example, cases where the disease is chronic, and confined to the larynx, and yet where acute inflammation follows the opening of the trachea; also cases where the wind-pipe has been cut with suicidal purpose, and the same result has followed. We could mention several of these, but will give merely one of each kind, and, to avoid any supposition of our opinion being biassed, we will make no selection of the best-marked, but relate the last two cases which have occurred.

CASE 58.—A woman, æt. 34, was in the hospital for disease of the cartilages of the larynx. She was seized with so much difficulty of breathing, that it was necessary to perform tracheotomy. This gave instant relief, and the patient appeared doing well, when symptoms of bronchitis and pneumonia came on, and she died eleven days afterwards. The *post-mortem examination* showed the cartilages of the larynx extensively diseased, and with considerable sloughing and suppuration around. The opening in the trachea presented the usual appearances; below this point the mucous membrane of the trachea and tubes of a greenish colour, and covered with a dirty purulent mucus. There were masses of hepatized tissue in the lungs; some of these had softened, and one was gangrenous.

CASE 59.—A woman, æt. 60, cut her throat, severing the larynx just above the thyroid, but not opening any large vessels. She was able to swallow food, but died seven days afterwards. The *post-mortem examination* showed the whole surface of trachea and bronchial tubes, as far as their extreme termination, covered with a purulent mucus. This was of a dark-greenish colour near the wound, and of a creamy character in the smaller bronchi.

PNEUMONIA, BRONCHITIS, &c.

It is well known that the so-called inflammation of the lungs in children is a disease very different in character from the affection bearing the same name in adults. For whereas, in the latter, a whole lobe or lung becomes consolidated, in children the disease affects only scattered lobules, and in simple

cases, indeed, the tubes alone. In cases which recover, probably little more than a bronchitis has existed, while in bad cases, and fatal ones, it seems as if the inflammatory process crept down the tubes, and invaded the lobules at their termination. It has been found of late years that much of this so-called lobular pneumonia is delusive, as the appearance is due to a simple collapse of the lung-tissue; the difference between the two conditions being sufficiently well marked in most cases. It is, without doubt, a fact that obstruction of the bronchial tubes leads to this condition, a good example of which was seen in the case described as No. 51, where a bean became impacted in the bronchial tube; as a necessity the whole lung collapsed. In infants of feeble powers this return of the lung to the foetal state (or atelectasis,¹ as it is called) is not uncommonly seen, and so in various other instances. It has also been particularly observed in whooping-cough; and in reference to this disease, we would give our opinion that too much attention has been directed to this newly-discovered morbid state; for we have found that if the inflammation of the tubes has been at all of an acute character, that this has been propagated to the tissue, and thus it happens that the two morbid conditions are combined. Not only are there certain lobules which present the dark, depressed surface on the lung, but if these are examined they will be found granular, often soft, and containing abundance of exudation corpuscles. We think, therefore, that a simple collapsed condition in the bronchitis of children is less common than one associated with an inflammatory process.

¹ We have already had occasion, in this journal, to remark on the wonderful power of observation possessed by Dr. Bright, and that in his "Medical Reports" there is scarcely a morbid condition which has attracted attention of late years, that escaped his grasp. Thus the relation between the pancreatic secretion and fat, the discoloration of organs in intermittent fever, have already been referred to; and now we have to remark, that in a case published more than thirty years ago, Dr. Bright had occasion to note this collapsed state of the lung, which is now regarded amongst our latest pathological discoveries. He says, "I had the opportunity, some time ago, of examining the chests of two children who died of whooping-cough. In both, the breathing had become more and more laborious until death. There was not a vestige of what we could ascribe to pneumonic inflammation; but the greater part of the lung was in a state of decided emphysema, while many of the lobules, about the edges of the lungs, were flattened, as if they had not admitted of the ingress of air for a considerable time. The bronchial tubes were a good deal loaded with viscid mucus."

We will relate one case of hooping-cough where this condition is seen ; but it is spoken of in several other instances, as at Cases 27, 29, &c.

Occasionally this peculiar broncho-pneumonia of children is met with in adults ; and if so, from the absence of the ordinary physical signs, presents great difficulties in diagnosis. We will relate the case of a girl, aged 15, who was under our care for this affection, and whose case for a considerable time was very obscure.

Should recovery occur in a child who has been the subject of bronchitis, and collapse of the pulmonary tissue, we can easily foresee the result—that the lung would waste, and the tubes become dilated. Before the time of Corrigan's researches, it was considered that dilatation of the bronchia implied an active disease in them, and that in the so-called cases of cirrhosis of the lung, the intervening indurated tissue resulted from a subsequent inflammatory process ; it is now, however, generally believed, with that physician, that the commencement of the disease is in the pulmonary structure, and that it is by the wasting and contraction of this that the dilatation of the tubes ensues. In the disease under consideration, however, the process is not quite so intelligible, since no inflammatory condition has been present in the lungs, the disease, in its commencement, being a bronchitis ; if this latter, however, should produce a collapse of the pulmonary tissue, there is just the same reason for the expansion of the tubes as in the former case, and to this may probably be added a yielding of the walls from the softening process of the inflammation. Although we say the bronchitis is the first morbid condition, the dilatation of the tubes is no doubt due to the collapse and contraction of the tissue which results from the obstruction to the air-passages ; if this be so, the process is closely allied to what occurs in the cirrhus lung. Several examples of this affection have come under our notice, but we will merely relate one, in which the dilatation of the tubes at the base of the lungs was so remarkable, that all the signs of a cavity were produced.

Hooping-cough—lobular pneumonia and collapse of lung.

CASE 60.—A boy, æt. 13 months, had stomatitis gangrenosa following measles, and at the same time hooping-cough had existed for six weeks. On *post-mortem examination*,

the whole of the air-passages were found in a state of sub-acute inflammation; the mucus membrane being of a bright-pink colour, and covered with a creamy mucus. The lungs were condensed in several places. Thus, at the anterior and lower edge of the right lung, a hardened mass could be felt; also, the whole of the outer edge of the lower part of the left lung was similarly condensed. These portions were slightly more shrunken than the healthy parts, and were dense and heavy. When the lungs were inflated, they remained unaltered, but the contrast between them and the remainder of the lung became then the more striking; the latter filling out and becoming of a pale colour, whilst their lower portions retained their red hue, and their surface below the adjacent tissue. The reason for its non-expansion was clear when cut through; it then being seen that some inflammatory exudation was also present, from its granular appearance, and by granule masses observable by microscope.

Infantile broncho-pneumonia.

CASE 61.—A girl, æt. 15, was taken ill three weeks with severe cold; and when first seen some days afterwards, was exceedingly ill, and so depressed that it was thought she had fever. The tongue was dry and furred, face flushed and livid; frequent delirium; quick breathing, and lungs evidently affected, but scarcely any expectoration. To the day of her death, it was not very clear whether it was a case of simple chest disease, or the same associated with fever. On *post-mortem examination*, the lungs were the only organs found affected. The bronchial tubes were acutely inflamed, and covered with secretion. The posterior parts of both lungs were solidified, and almost airless; when incised, this was found to be due to different conditions of lobules, some being in a state of red hepatization, others of gray hepatization, while others were simply airless. As a whole, the section did not present the ordinary appearance of a uniform hepatization, and thus did not at all resemble the pneumonia of the adult, but rather that of childhood. There was no state of the viscera or body which would have indicated either typhus or typhoid fever.

Dilatation of tubes after hooping-cough.

CASE 62.—A boy, æt. 12, had suffered with a cough ever since infancy; in summer time he was better, though never well, but in the winter was always laid up with the severity of it. His chest had assumed the shape seen in asthmatic persons, being of a barrel shape, or rounded; the boy being round in the shoulders, and having these parts raised. When seen as the winter was coming on, he was exceedingly ill, breathing with great effort; his face livid, and the expectoration purulent and very profuse. Bronchial râles existed throughout the chest; and these were so large at the bottom, that it was a question whether some disorganization of the tissue did not exist, especially as the upper part of the right side was dull on percussion. The lad soon afterwards died, when the body was found to be much wasted, and the chest barrel-shaped, as above mentioned. The right upper lobe was consolidated by a lobular inflammation, which had occurred throughout it; about half the amount of tissue in this lobe had been changed into gray hepatization. No tubercles present in any part of lung, or other

organ of body. The bronchial tubes throughout both lungs were remarkably diseased; the mucous membrane was of an intense red colour, and so swollen, that in some of the smaller tubes it nearly closed them. It rose from the surface like a piece of soft velvet laid upon it, and of a dark red, from excessive vascularity. The tubes, when cut, were thus spongy and soft. At the lower lobes they were also remarkably dilated, and this was especially the case in the left lung, where, towards the surface, instead of being so narrow as scarcely to allow the point of the scissors, they became dilated to the size of the fingers of a glove, and in one or two instances expanded into cavities near the surface. The walls of the tubes were very thin; tissue between, dense and airless. A moderate amount of mphysema existed at edges and apices of lungs. Other organs healthy.

Enlargement of bronchial glands, producing symptoms of hooping-cough.—One theory of the cause of hooping-cough is pressure on the laryngeal nerves from enlargement of the lymphatic glands. As an extended observation has shown that this is not the case, but only in some exceptional instances has the enlargement of the glands been found accompanying symptoms resembling those of hooping-cough, we come to the conclusion that these exceptional cases were taken as an evidence of a rule which should have been oppositely interpreted, and that wherever such morbid condition was found it should have been a proof against, rather than in favour of, hooping-cough. We have seen several instances where children had violent paroxysms of coughing, resembling very much those of pertussis, and where, after death, an explanation was found in the bronchial glands involving the laryngeal nerves. In one or two cases the symptoms have suggested this, and where the after-death examination has shown the diagnosis to be correct. Out of several, we give the last case which occurred, as an example.

Another point of interest in this case has reference to the statement that numerous lobules were hepatized, or filled by a deposit which was probably scrofulous. This shows how difficult it is to distinguish one from the other, if, indeed, they be in many cases distinguishable; since we have no doubt that the scrofulous is a mere modification of the inflammatory. In most cases, however, we should endeavour to ascertain to which kind the deposit belongs, since a pure inflammatory exudation is often called scrofulous, it being very easy to mistake an ordinary inflammatory product, occurring in individual lobules, for soft tubercle.

CASE 63.—A girl, æt. 4½ years, when first seen was very ill, with great oppression of breathing, as of broncho-pneumonia, and shortly after died of convulsions. She was said to have whooping-cough, or what was supposed to be whooping-cough; and, at the same time, symptoms which were rather laryngeal. The *post-mortem examination* showed the brain to be quite healthy. The bronchial glands were very much enlarged by tuberculous deposit, forming large cheesy tumours surrounding the trachea and bronchial tubes. The pneumogastric nerves passed through the mass of glands, and the right appeared quite compressed in consequence. The bronchial tubes were not inflamed; they merely contained some mucus. The right lower lobe was consolidated by lobular inflammation; numerous lobules being hepatized by the deposition of a product which, from its appearance, was, no doubt, scrofulous. Also a few similar deposits scattered in other parts. No miliary tubercles; mesenteric glands tuberculous, as well as ileum.

Pericarditis.—We occasionally meet with pericarditis in children, and the question arises—Is it idiopathic or rheumatic? The fact of rheumatism not showing itself in so marked a form as in adults has led, no doubt, in many cases, to the supposition of its absence when it has really been the origin of the disease. In the first two cases given, the cause of the acute inflammation in the chest is not very clear. It is very possible that injuries, as falls, may sometimes give rise to acute inflammation in the chest, as seen in the third case given; and that a very severe internal lesion may occur without the parietes evidencing much sign of injury, we illustrate by another case.

CASE 64.—A girl, æt. 6, was said to have been ailing a week, with pains in all the limbs; there was, however, no swelling of the joints. At the expiration of another week, the child still being very ill, a friction pericardial sound was heard, but the rheumatic swellings had never manifested themselves; the pains in the limbs being the principal symptom denoting the character of the affection. The patient continued ill for some days, when she became lower, and had fits of screaming and startings, and much difficulty of breathing came on. She died three weeks after the onset of the symptoms. The *post-mortem examination* showed the heart to be universally adherent by a thick layer of lymph surrounding it, and with this was also much blood mixed. This exudation of lymph and blood was about the third of an inch thick; in some parts these two materials formed distinct layers of themselves. The muscular tissue appeared healthy, as well as the endocardium. Slight pleurisy uniting left lung to chest and pericardium, and lungs had recent lobular pneumonia in some parts.

CASE 65.—A child, æt. 8 months, was dying when first seen, labouring under great dyspnoea, &c. It was said that she had been ill two months; but the illness was not known to have followed rheumatism, scarlatina, or other disease. The *post-mortem examination* showed that the whole of the serous membranes of the chest had been in a state of chronic inflammation, commencing probably many weeks before, and continuing up to the time of the patient's death. Both

lungs universally adherent, and in parts by tough fibrous tissue; amongst this, however, there was recent lymph, and on both sides circumscribed spaces full of purulent fluid; in fact, so many local emphysemas. On the right side about two or three ounces of thick pus were situated between the lung and cartilages of the rib, a thick layer of lymph circumscribing the abscess; on the left side there was an equal quantity of pus at base of lung. The lungs were healthy, with the exception of a single small mass of lobular pneumonia, situated in the upper part of the right lung. No tubercles. Little creamy mucus in tubes. Pericardium presenting an inflammation of the same character as the pleura, that is, an inflammatory process of some weeks' standing, continuing up to the present time. Thus there was recent lymph covering the serous membrane, and which was easily detached; besides this, there was a firm leathery coating covering the heart, and in places where this came in contact with the pericardial sac, there were firm masses of lymph connecting the two, and in process of forming adhesions. These were with difficulty separated, being very firm and tough. All the other organs healthy, and no tubercle in any part.

Pleurisy from injury.

CASE 66.—A boy, æt. 11 months, fell off a chair, and a piece of iron upon him; but he was not known to have been injured by it. Three days afterwards, the mother observed his breathing to be short; this increased in difficulty, so that on the following day, when first seen, he had all the symptoms of pneumonia, together with great tumefaction of the right side of the chest. He died on the sixth day after the accident. On *post-mortem examination*, the subcutaneous cellular tissue was found infiltrated with pus; the pectoral muscles softened, and occupied by the same matter; and abscess in the chest. Pus was seen bulging outwards from between the first and second ribs. The ribs and clavicle had not been injured in any way. At the upper part of the chest, between the parietes and the lung, was a quantity of matter about to burst externally. The bronchi contained creamy mucus; the lower lobe of right lung was airless, but tough, and its condition appeared to be due to collapse rather than hepatization.

Laceration of lung without injury to chest.

CASE 67.—A boy, æt. 7, was run over in the street, the wheel passing over chest and abdomen: he survived the injury two hours. The breathing was very difficult, and there was spitting of blood. There was no bruise on the chest, where the wheel was said to have gone; and on opening it after death, no fracture of rib or any other injury to chest-walls could be discovered; but there was a laceration of the lung at the lower border of the right lobe, and the organ was collapsed. There was blood and air in the cavity of the thorax.

CANCERUM ORIS, &c.

This disease is, as is well known, generally fatal; but although we have examined several cases after death, we are not able to say much as to its true pathology. It is said to

occur generally after the exanthemata, and this is our experience, although we cannot say to what extent this is true, as our facts are too few in number. Moreover, there does not seem an entire agreement among observers as to the precise course which the disease pursues, and what exactly is its original seat; thus, by some the disease has been said to commence on the cheek, and by others in the gum. We believe that both may occur, as we have seen examples of each; and we think that when commencing on the gums, it may be only an aggravation of the disease which was fully described by Mr. Salter in the last volume of this work—an affection where an ulceration of the gums occurs after scarlatina, and the teeth subsequently fall out. If this be so, some explanation is afforded of the pathology of stomatitis gangrenosa, since we can perceive, as the author just mentioned remarks, how, in a general desquamation of the skin, the teeth may be involved; and how also, in a weak, puny, or cachectic infant, a gangrenous process might result. One objection to this lies in the fact of the teeth of the lower jaw being principally affected in the disease just named, whereas gangrene commences on the upper gum. This explanation is only a surmise, however, and in the case of the cheek being primarily affected, we know of no explanation as to its cause. In some cases, given below, it will be seen that the blood-vessels and surrounding parts of the diseased structure were examined, but nothing ascertained whereby a reason could be given for the cheek being affected in this manner, rather than any other part of the body. It will be seen that in two a fatty liver was found (one not here related), which might raise a suggestion as to this being an evidence of an unhealthy condition of the system, especially as the same morbid state of liver is sometimes discovered in connection with sloughing and gangrene elsewhere. There is, however, considerable difficulty in the maintenance of this; for not only is there a question as to the connection between a diseased liver and gangrene, but also a less easy one respecting the actual amount of morbid state supposed to exist in a liver which is fatty. We do not, indeed, know what excess of fat a liver may contain compatible with health—what changes in respect to its amount may be constantly going on; for there is every reason to believe that, during certain illnesses, a deposition

may occur, and that on recovery the fat may again be absorbed. There can be no hesitation, however, in styling an extremely fat liver a morbid organ; and if so, there must have been present at the same time some disturbance to its function. We think, therefore, it is important to notice the fact of this condition having been found in *cancrum oris*; and we might mention that in the cases of two children lately, who had died in a cachectic state, of very obscure affections, a fat liver was the most marked morbid state discovered in the body.

We will first relate the three fatal cases, in which it will be seen that there was a history of measles in one only. The fourth case shows the ordinary site of the disease in the cheek, and is remarkable as commencing before the exanthem had quite disappeared. The fifth case appeared to show an extension from the jaw; and the last is interesting as following a burn.

CASE 68.—A boy, *æt.* 21 months. The mother stated that, three weeks before his death, he had a mild attack of chicken-pox, followed by diarrhoea; and that for this latter complaint she procured some powders at the chemist. She then found a swelling of the face, and, upon examining the mouth, discovered some ulceration of the gums; this continued until the child was brought to the hospital nine days afterwards. The whole of the right cheek was then destroyed by gangrene, and emitting a very fetid odour. The gangrene continued until the whole of the pharynx was exposed, as well as the bones of the upper maxilla, and the nose also was destroyed. The child died eighteen days after the commencement of the disease. *After death*, the parts surrounding the gangrenous spot were carefully dissected, to see if any light could be thrown upon the cause of the disease. The arteries and veins of the neck were traced, but no alteration in these parts was discoverable. The facial artery, just before entering the border of the slough, was completely filled with a firm clot of blood; but this was no more than might have been expected. The cervical lymphatic glands on both sides of the neck were much enlarged, but contained no adventitious deposit. The enlargement appeared quite recent. The larynx was healthy, being not at all affected by the disease in close proximity to it. The lungs were healthy, containing no tubercles; nor were there any in other parts of the body. The liver was pale and very fatty. All other organs healthy.

CASE 69.—A boy, *æt.* 13 months, was said to have had measles six weeks before his death, followed by whooping-cough. About a fortnight before death (but the exact day not ascertainable), it was also said, blisters appeared on the tongue and mouth, and afterwards the gums became affected, and subsequently the lips. When brought to the hospital four days before death, there was no perforation through the cheek; but the whole of the skin of this part was black and gangrenous, and two black spots existed on the upper lip. The gums also were involved, the teeth were loose, and the mouth was full of a very offensive, dark, bloody exudation. The whooping-cough continued. The breathing was quick and oppressed.

Post-mortem examination—The mouth, in the condition above mentioned, emitting a horribly fetid odour; the lips and chin quite black, and extensive ulceration of the gums and lips within. The following conditions of broncho-pneumonia had nothing to do with the cancrum oris, but were, no doubt, due to the hooping-cough. The trachea and bronchi acutely inflamed; mucous membrane of a bright pink colour, and the surface covered with a white creamy mucus; and the smaller tubes also had much tenacious mucus. The lung was inflamed, and condensed in several parts; thus, at the anterior and lower edge of the right lung, a hardened mass could be felt; also, the whole of the outer edge of the lower part of the left lung was in similar condition. These were slightly more shrunken than the healthy portions, and were dense and heavy.

CASE 70.—Girl, æt. 3½ years. Always delicate, and had frequent cough. Twelve months before death had hooping-cough, which lasted three months. Was in tolerable health until four weeks before her decease, when the chest affection again coming on, a medical man was called in, and, according to the statement of the mother, calomel powders were given. At the end of a fortnight, a black spot was observed inside the lip, on the right side, and on the corresponding gum; and soon afterwards the teeth fell out. The mother said she had had no scarlatina, measles, or any other fever. The child was admitted with a large black gangrenous slough on the right cheek, passing through the mouth, and involving the gums. The *post-mortem examination* showed inflammation of the bronchial tubes, all of them, including the smallest, being filled with a creamy mucus. The lung displayed miliary tubercles in several parts. Elsewhere there were solidified lobules, which were rather soft, and gave the idea of their strumous character; although the appearance was not much more than is usually seen in the advanced broncho-pneumonia of children. The bronchial glands were considerably enlarged by tuberculous deposit. Firm ante-mortem clot in appendix of right auricle. Liver congested, but otherwise healthy, as well as other organs.

CASE 71.—A little boy, æt. 16 months, came among the out-patients in a feeble, wasted condition, since the time of weaning. Subsequent to his visit he had measles; and on the same day on the following week he was brought with a lump in the left cheek, with a black, gangrenous spot in the centre, the commencement of cancrum oris. On looking within the mouth, the mucous membrane was quite healthy.

CASE 72.—A girl, æt. 5, had measles four months before her death, and quite recovered. Three weeks before her death, having fallen into a bad state of health, without any apparent cause, she was brought amongst the out-patients with ulceration of the upper gum, and necrosis of the alveolar process. While separation was going on, the ulceration rapidly spread to the cheek, which then became gangrenous, constituting, indeed, cancrum oris, and destroying all the side of the face.

CASE 73.—A boy, æt. 3, was admitted into the hospital for a burn on both arms and neck. The child was doing well, when, at the expiration of three weeks, the upper lip was observed to be swollen, and the mucous membrane ulcerated. The ulceration rapidly spread upwards, on the left side, as high as the nostril, and the teeth dropped out; this continued for three days, when the child died. He had scarlatina several months before the accident, at which time he was quite well.

CAUSE OF DEATH FROM BURNS AND SCALDS.

As we stated at the commencement of this paper, a sufficient apology would be found for the study of the human body after death, if it only enabled us to discover the proximate cause of dissolution, and threw no light on the pathological conditions which were first in operation; for by this discovery we are able to discern the tendencies to death in particular directions, and are thus in a position to endeavour to obviate them. We have already stated¹ that, as regards the effects of burns, we have not found the ulceration of the duodenum which has been described; but we have observed that death has been immediately due to a bronchitis or pneumonia. If the patient survive but a short time, we put down the fatal result to shock; if, also, he live for a few days, and no morbid appearance be found in the viscera, we are forced to attribute it to the same cause. That the nervous system is directly affected is seen in the fact of tetanus resulting from burn, two cases of which we have already given in this work, and we now append a third. Generally, however, death is caused by pulmonary disease; and here a question arises, whether this be owing to any immediate sympathy between the cutaneous surface and the lungs, or whether it be not due to a poisoned condition of the blood, such as we suppose occurs in pyæmia. A perusal of the cases given below strongly tends to support the latter supposition, these cases being not selected, but given in the order in which they occurred; it will be observed, also, how common a purpuric state of the organs is,—a condition denoting, above all others, an unhealthy state of blood. Moreover, deposits in the organs, as the kidneys, point in the same direction; these, however, being fibrinous rather than purulent, may show that the results of burn are not simply pyæmic, although of that character, and evidencing, beyond doubt, an infection of the blood.

Burn. Shock.

CASE 74.—A boy, æt. 2, scalded his face, neck, and chest, with hot water, and he died eight days afterwards. The body was carefully examined, and no disease could be found to which to attribute his death.

¹ 'Guy's Hospital Reports,' ser. 3, vol. ii,

Burn. Pneumonia.

CASE 75.—A boy, æt. 5, burned very much the upper part of the body, from his clothes catching fire, and died nine days afterwards. *Post-mortem examination*—Right lung adherent by old cellular tissue. The lower lobes of both lungs in an early stage of inflammation, that is, red hepatization. Besides this, there were numerous lobules in a more advanced stage of inflammation, being white, granular, and soft, from which it appeared as if a general inflammation had supervened in a previous lobular disease. Besides this, there was a mass of old disease in one lung about the size of a walnut, consisting of a low form of unorganizable tissue. There was no appearance of tubercle in any part of the body; but the child was rickety. All other organs healthy.

Burn. Bronchitis.

CASE 76.—A boy, æt. 1 year; burnt face and upper part of body. He lived thirteen days. He appeared to die from the chest, and after death all the tubes were found filled with a purulent mucus. The remaining organs healthy.

Burn. Broncho-pneumonia.

CASE 77.—A girl, æt. 15, scalded her abdomen and legs with a kettle of boiling water. She lived fourteen days, having cough and dyspnoea the last six days. The *post-mortem examination* showed the bronchial tubes filled with mucus; the pleura covered with purpuric spots. The lower lobes of lungs contained numerous inflamed lobules in a stage between red and gray hepatization; on the surface were also numerous dark patches, depressed, and which might have been in part due to collapse of the tissue, but they also contained inflammatory exudation. Stomach contained a hæmorrhagic erosion. Liver pale and fatty. Other organs healthy.

Burn. Kidney. Purpura.

CASE 78.—A girl, æt. 3, burnt about the neck and arms, from clothes catching fire. She lived a fortnight, the skin ulcerating. On *post-mortem examination*, the surface of lungs was found covered with purpuric spots; the spleen affected in same manner. The kidneys contained small fibrinous masses in the cortical structure. No affection of stomach or duodenum; lower end of ileum covered with a tender layer of lymph (diphtheritic).

Burn. Kidney. (Nephritis?)

CASE 79.—A boy, æt. 6, burned a large part of body, from clothes catching fire; and lived four weeks, dying from exhaustion. The *post-mortem examination* showed surface of the body in part suppurating, and back sloughing. The lungs were covered with purpurous spots; and on section, numerous lobules were found in the first stage of pneumonia. The stomach, intestines, liver, and spleen, healthy. The kidneys were very large, swollen, and uneven on the surface

and mottled all over with white deposit and ecchymoses. A section showed the same characters within. The tubular portion of a dark-red colour, and the cortical containing effusions of fibrin and blood, giving the whole surface a mixture of red and white. At first sight the white portions appeared to be purulent or tuberculous deposits; but a closer examination showed them rather to be fibrinous.

Burn. Lobular Pneumonia.

CASE 80.—A girl, æt. 6, burned upper part of body, from clothes catching fire. The sloughs gradually separated, and the sores granulated; but subsequently purpurous spots appeared on the body, and she died between four and five weeks after the accident. At that time the child was said not to be well, though it could not be learned what positive disease she had. The body was extremely wasted, and covered with purpuric spots. The surface of the lungs was covered with a thin layer of lymph, from acute inflammation. The lungs were the subject of universal lobular pneumonia. Small masses of hepatized tissue throughout the lungs, and many of them softening down into a purulent-like matter, which, when washed out, left small cavities. From the amount of deposit, and its breaking down in this manner, it became a question how far it was of a scrofulous character, and whether any degree of it existed before the injury. From its acute nature, however, it was supposable that the whole could have occurred in the time. Bronchial glands much enlarged, as in pneumonia, but with no deposit. The mucous membrane of trachea and bronchi acutely inflamed, being injected, swollen, and granular, and covered with a creamy mucus. The liver was very pale, and very fatty. Stomach, duodenum, and other organs, healthy.

Burn. Pleuro-pneumonia.

CASE 81.—A boy, æt. 2, died twelve days after a burn on the side of body, arm, and leg. The *post-mortem examination* showed a slight inflammatory exudation of lymph on the surface of the lungs. The latter were the subject of general lobular pneumonia; masses of hepatized tissue being scattered throughout their substance. All the other organs healthy.

Burn. Tetanus.

CASE 82.—A girl, æt. 9, died nine days after her clothes catching fire. About twenty-four hours before her death she became very restless, and subsequently all her limbs and body stiff, as in tetanus. She had no regular convulsions. The body presented burns on upper part of chest and both arms; sores granulating and suppurating. The brain appeared quite healthy; also the spinal cord. All the organs throughout the body quite healthy.

THE
PHYSIOLOGY OF SLEEP,

By ARTHUR E. DURHAM.

THE restorative influence of sleep, its periodical recurrence and average duration, the circumstances which induce it and favour its continuance, and those which dispel its charm,—the sleeper's unconsciousness of the outer world of sense and action, and his introduction to the inner world of dreams,—these phenomena, and many more, are so familiar, and at the same time to our limited apprehensions so wonderful, that they have, almost of necessity, been the subjects of correct observation and frequent comment. The conditions of the nervous system, however, and those other internal phenomena of sleep which give rise to, or at any rate are concomitant with, its external and more palpable phenomena, have been too readily regarded, not as legitimate fields for observation and experiment, but as themes for baseless speculation. Physiologists, for the most part, seem to have agreed with metaphysicians and poets, in considering the nature of sleep as veiled in impenetrable mystery, and altogether beyond our powers of investigation. "It is plain," writes one of the most distinguished philosophers of the present day, "that in some respects the condition of the nervous system must be different during sleep from what it is when we are awake; but it seems impossible that we should know in what that difference consists, when we consider that neither our unassisted vision, nor the microscope, nor chemical analysis, nor any analogy, nor any other means at our disposal, enable us to form any kind of notion as to the actual changes

in the brain or spinal cord on which any other nervous phenomena depend.”¹

The opinion thus expressed by Sir B. Brodie is shared by most physiologists, and very generally received; to dissent from it, therefore, may seem somewhat presumptuous. Nevertheless, I venture to express my belief, that the examination of the living brain, exposed as I shall presently describe (especially when the eye is aided by the microscope), together with the careful consideration of certain obvious analogies, *may* do much towards enabling us to penetrate the mystery of the subject, and to advance some steps in the right understanding of the true nature of sleep, and of some other conditions of the nervous system. I cannot but hope that the observations recorded in the following pages, and the reasoning employed, even if they should be considered insufficient to establish my hypothesis beyond dispute, will at any rate be deemed sufficient to justify my apparent presumption in entering upon the subject.

Considered *psychologically*, I think sleep may be best defined to be a state in which volition, sensation, and consciousness are suspended, but can be readily restored upon the application of some stimulus. “That sleep alone is healthy,” says Dr. Wilson Philip,² “from which we can be easily aroused. If our fatigue has been such as to render it more profound, it partakes of the nature of disease.”

Considered *physiologically*, I believe, sleep may be most correctly regarded as the period of the brain’s repose. Every living structure passes through alternating conditions of repose and activity: when active, the tissue is consumed; when at rest, the tissue is nourished, and the waste repaired. Temporary inactivity, we have reason to believe, is a condition essential to perfect repair. The hands of an ordinary clock do not go round while the weights are being wound up, neither perhaps do functional activity and nutrition take place at the same moment, in any one of the individual parts of which an organ is made up. Different parts of the same organ may be at the same time in different conditions—one part may be undergoing repair while another part is in action, but there is reason to believe that in the same part, the two conditions cannot be simultaneous.

¹ ‘Psychological Inquiries,’ p. 134.

² ‘Philosophical Transactions,’ 1832.

Consciousness, sensation, and volition, are the great manifestations of the brain's functional activity; of necessity, therefore, they cannot be manifest when the activity of the brain ceases, whatever may be the cause of such cessation. Now sleep appears to be that particular state of cerebral inactivity, which is essentially associated with the nutrition and repair of the brain substance. This definition serves to distinguish (at any rate, in idea) between sleep and certain other conditions to which it has been supposed to be allied, and to which therefore some allusion must be made.

Various circumstances—such as deficient supply of arterial blood, the action of certain drugs, and pressure, whether arising from extravasated blood, effused serum, or depressed bone—are well known to interfere with the due performance of the functions of the brain, in such a manner as to cause partial or complete suspension of volition and sensation. Thus are produced lethargy, torpor, and the various kinds of coma: some of the phenomena of these states more or less closely simulate those of sleep; and it is frequently only by the comparative ease or difficulty with which sensation can be excited, and the slumberer aroused, that we can discriminate, during their continuance, between one or other of these abnormal conditions and healthy sleep. But if the patient recover, instead of waking up refreshed and invigorated, as he would from sleep, he is depressed and exhausted. Hence it may be inferred, that the processes of internal change are very different, however closely, to all external appearance, the two cases may resemble each other. This inference is confirmed by observations I have made upon the brains of animals, during life and after death.

While the brain is at rest, the organs of sense and the voluntary muscles are neither stimulated to action, nor kept on the *qui vive*. They also are at rest, and opportunity for their repair is afforded. Thus the repose of other parts is ensured by the repose of the brain, and so far the idea of sleep expressed in the present paper is in accordance with the remark of Bichat—"Le sommeil général est l'ensemble des sommeils particuliers." Again, we know that the reparative processes of the body generally are differently affected by different states of the nervous system. It is by no means improbable, that the condition of the encephalic centres during sleep directly

favours the nutrition of the organs with which these centres are severally associated. Thus, the repose of the brain not only gives opportunity for the nutrition of other parts, but may actually aid the processes by which this nutrition is effected.

Much of the obscurity and confusion in which the subject is involved has, I believe, arisen from the vague and indefinite sense in which the word sleep has been too often employed. It is for this reason that I have at some length stated what appears to me the true idea of sleep. We hear of the "sleep of plants." Grateful wonder is sometimes expressed that neither the heart, nor the muscles of respiration require to partake of the benefits of sleep. And in the writings of Dr. Marshall Hall, it is repeatedly stated, "The true spinal system never sleeps." Such, and many similar expressions appear to me to denote a want of proper appreciation of what is implied by the word sleep. In some instances the term is obviously inapplicable, except in a metaphorical sense; in others it seems to be supposed that, apart from sleep, there can be no rest. It is obvious, however, that rest and sleep are not convertible terms. Rest is a term of general, sleep a term of special, application. The arrangements of the body are such that proper periods of rest are guaranteed to every organ. The heart pauses after each pulsation; every breath we draw is followed by a period during which the nerves and muscles of respiration repose before they are again aroused to action. So is it with all the vital tissues of vegetable, as well as of animal organisms: the alternating intervals of rest and action may be seconds or hours—their duration varies with the tissue, but in every case, the due proportion is maintained. Such periodical states of rest, however, are not sleep, nor even necessarily concomitant with it; for if the temporary suspension of sensation and volition is essentially included in the idea of sleep, those creatures which do not possess these faculties certainly cannot be said to sleep; nor can those organs *directly* participate in sleep, which are only *indirectly* concerned in the functions of sense and voluntary action.

Sleep then being regarded as that period of cerebral inactivity during which nutrition of the brain substance takes place, two questions arise. First. Upon what conditions of the organ does this inactivity depend, or rather with what

palpable conditions is it associated? Secondly. What are the proximate causes of such conditions?

It is plain that some kind of reply to the former of these questions might be obtained, if we could examine the living brain during sleep and under different degrees of excitement. Now it is well known that cases have occurred in which this could be done to a certain extent. "The woman of Montpellier, whose case is recorded by Caldwell, had lost part of her skull, the brain and its membranes lying bare. When she was in deep or sound sleep, the brain lay in the skull almost motionless; when she was dreaming, it became elevated; and when her dreams (which she related on waking) were vivid or interesting, the brain was protruded through the cranial aperture. Blumenbach also witnessed a sinking of the brain during sleep, and a swelling with blood when the patient awoke."¹ But these, and all other accounts of similar cases which I have been able to obtain, however interesting and valuable they may be as far as they go, are of necessity incomplete and unsatisfactory. It occurred to me that the artificial exposure of the brains of living animals might afford opportunity for more definite observation and further inquiry. With this idea I have made numerous experiments and observations. The following details of one or two of the most successful will clearly convey the general result.

A dog having been thoroughly chloroformed, a portion of bone about as large as a shilling was removed from the parietal region of the skull by means of the trephine, and the subjacent dura mater partially cut away. The portion of brain thus exposed, seemed inclined to rise into the opening through the bone. The large veins over the surface were somewhat distended, and the smaller vessels of the pia mater seemed full of dark-coloured blood; no manifest difference in colour between the arteries and veins could be perceived. The longer the administration of the chloroform was continued, the more distended did the veins become. As the effects of the chloroform passed off, the animal sank into a comparatively natural and healthy sleep. Corresponding changes took place in the appearance of the brain: its surface became pale, and sank down rather below the level of the bone; the veins were no

¹ 'Psychological Journal,' vol. v, p. 74.

longer distended; a few small vessels, containing blood of arterial hue, could be distinctly seen; and many which had before appeared congested, and full of dark blood, could scarcely be distinguished. After a time the animal was roused; a blush seemed to start over the surface of the brain, which again rose into the opening through the bone. As the animal was more and more excited, the pia mater became more and more injected, and the brain substance more and more turgid with blood; the surface was of a bright-red colour; innumerable vessels, unseen while sleep continued, were now everywhere visible, and the blood seemed to be coursing through them very rapidly; the veins, like the arteries and capillaries, were full and distended, but their difference of colour, as well as their size, rendered them clearly distinguishable. After a short time the animal was fed, and again allowed to sink into repose; the blood-vessels gradually resumed their former dimensions and appearance, and the surface of the brain became pale as before. The animal slept in a perfectly natural manner. The contrast between the appearances of the brain during its period of functional activity, and during its state of repose or sleep was most remarkable. In order, however, to be quite sure that I was not misled by fancy, nor yet by faulty memory, but that the difference was really great, I operated on two animals, and kept them alternately in different states. The animals being placed side by side, the appearances in the two cases could be satisfactorily compared.

The state of the blood-vessels was more thoroughly examined by means of a powerful lens. The tube of an ordinary microscope held in the hand (with inch and two-inch object-glass and middle eye-piece) was also used with advantage.

It was suggested to me, that the perforation of the skull placed its contents in an unusual condition with regard to atmospheric pressure, and that thus, an unnatural state of the circulation might be induced. But it is plain that the pressure of the atmosphere was the same, whether the animal was asleep or awake, and could therefore have nothing to do with the causation of those different appearances which characterised the two states. However, it was evident that the exposed portion of the brain lost that support which the cranium naturally afforded. It was probable also that the projection

of the brain through the opening might cause pressure upon some of the blood-vessels, and thus give rise to the appearance of increased vascularity or congestion. To obviate these and other possible objections, I replaced the portions of bone removed by accurately-fitting watch-glasses, and rendered the junction of their edges with the bone air-tight, by means of inspissated Canada balsam. The different appearances of the brain could be satisfactorily observed through the glasses, and were found to correspond as nearly as possible with the above description.

I satisfied myself of the accuracy of these observations by repeated experiments upon different animals. My experiments upon dogs were the most satisfactory; those upon rabbits least so. The results obtained were uniform, when the necessary and accidental difficulties of the case were successfully overcome. It need scarcely be said that, in the repetition of these experiments, the greatest care and considerable patience are requisite, together with many precautions, such as will suggest themselves to the experimental physiologist.

Now the observations thus detailed are manifestly opposed to the hypothesis that venous pressure is the cause of sleep. This hypothesis, however, has been promulgated by many eminent physiologists, and is, I believe, almost universally received: it is moreover reasserted and very ingeniously defended in the most recent publication on the subject.¹ Such being the case, I thought it necessary to make several further experiments for the especial purpose of determining the appearances and effects produced by distension of the encephalic veins. The result was exactly what I had anticipated. Pressure upon the jugulars of animals prepared as I have described caused manifest venous congestion of the pia mater. And when these vessels were completely obliterated by ligature, and the return of blood from the encephalon was so far interfered with as to cause torpor, the appearance of the brain differed remarkably from that presented during sleep. The difference was much more striking when coma and convulsions ensued.² The appearance of the brain most similar to that which characterises sleep, was pro-

¹ Dr. Cappie's 'Essays in Medical Science.'

² In order to produce such effects, ligature of the vertebral, as well as of the jugular veins, is usually necessary.

duced by ligature of both carotid arteries in young animals. The general results of ligature of the large blood-vessels going to, and from the brain, vary somewhat with the age of the animal, as might be predicted from a consideration of the anatomical changes which take place during growth.

Again : another proof that distension of the cerebral veins is not associated with sleep may be derived from what is known of the cerebro-spinal fluid, and its relation to the quantity of blood in the encephalic vessels. Hilton found that pressure upon the jugulars caused the cerebro-spinal fluid to flow rapidly from the ear of a patient suffering from fractured base of the skull ; whereas, it is well known that the fluid flows in diminished, and not in increased, quantity during the super-vention of sleep. These facts shew clearly a difference between the conditions of the cerebral circulation under venous distension and during sleep.

Lastly : the more the subject is considered, the more evident will it appear, that interference with the return of blood from the cranium causes torpor, not so much by pressure of distended veins upon the brain, as by the hindrance which necessarily arises to the due supply of arterial blood, and by the presence in the vessels and tissue of an accumulated proportion of carbonic acid.

Thus then, it may fairly be concluded that venous pressure is not the cause of sleep ; for it has been shown, first, that during sleep the cerebral veins are not distended, and secondly, that distension of the veins produces phenomena different from those which accompany sleep.

Besides leading to the negative conclusion stated, the experiments I have described show clearly that changes take place in the appearances of the brain, concomitantly with changes in the degree of excitement to which the organ is subject. They also indicate the nature of these changes, and render it manifest that there are two distinct normal conditions of the cerebral circulation ; the one corresponding to high functional activity of the brain, the other to its repose. The one may be termed the circulation of function ; the other, the circulation of nutrition. In the circulation of function, the quantity of blood is greater, and the rapidity of its motion is increased. In the circulation of nutrition, the quantity of

blood, and the rapidity of its motion, are both diminished. Between the extreme conditions there are, of course, many intermediate grades.

Propositions similar to these will be readily admitted to be true of all other vital organs. In most cases indisputable evidence can be adduced, and no possible difficulty can be raised. But when we attempt to apply such propositions to the brain, we are at once met by numerous objections, strongly urged by those physiologists who maintain that the total quantity of blood within the cranium must be invariable. This opinion has been repeatedly proved to be untenable by Burrows, Donders, and others, and is further shown to be manifestly opposed to fact by my own observations. It has, however, been made by Dr. Cappie¹ (the most recent writer on the cerebral circulation) to form an essential element in his hypothesis of sleep; for this reason I have thought it necessary to refer to the subject.

It is obvious enough, that the total contents of the cranium must be constant in quantity. Now, the variations I have described in the amount of blood in the encephalic vessels are accompanied by corresponding variations in the amount of cerebro-spinal fluid in the ventricles of the brain and in the subarachnoid spaces. That this is not only possible, but true, may be easily proved by experiment, and by observation in cases of fractured base of the skull, in which accident has prepared the experiment for us.

The rapidity with which the cerebro-spinal fluid can be absorbed and produced, is established by the original investigations of Magendie, confirmed and extended by those of Hilton, Ecker, and other physiologists; the correctness of whose conclusions may readily be tested by the repetition of their experiments. It is evident from the anatomy of the parts that, as the encephalic vessels become distended, the fluid can easily pass from the ventricles to the base of the brain, and from the subarachnoid spaces within the cranium into that of the spinal canal. When, on the other hand, the amount of blood in the vessels undergoes diminution, the pressure of the atmosphere on the surface of the body (transmitted by the soft tissues) causes the reascent of an equivalent

¹ 'Essays in Medical Science.'

amount of cerebro-spinal fluid.¹ The force thus exerted seems to have been overlooked by those who have been at a loss to account for the rise of the fluid from the vertebral canal.

Again, when the distension of the blood-vessels is lessened, the pressure to which they are subject is also lessened to a corresponding extent, and thus the effusion of fresh serous fluid is promoted.

A certain period of time is obviously necessary for the change in character of the circulation, and the due adjustment of the cerebro-spinal fluid. This period may be longer or shorter according to circumstances. It corresponds to the interval between sleeping and waking, and forms an essential element in the transition from the one state to the other. Our everyday experience affords illustration. When we are soundly asleep, we do not instantaneously awake to full possession of our faculties; still less do we pass suddenly, from perfect wakefulness into a state of healthy sleep. The intermediate conditions of the circulation associated with the periods of transition, could be distinctly observed, in the experiments I have already described.

The correspondence of the character of the circulation with the activity or repose of the organ having been thus demonstrated, the question naturally arises, Why does this correspondence exist? In other words, Why is it that the physiological condition of the organ, and the state of the circulation in it, are thus intimately related, and mutually dependent? A satisfactory answer may readily be derived from the following proposition. Oxidation of the brain-substance is concomitant with, and directly proportionate to, the development of cerebral activity.² Of the truth of this proposition we have three

¹ It is well known to those practical surgeons who have made any observations upon this point, that, in cases of fractured base of the skull, the cerebro-spinal fluid does not flow at all, or flows very slowly, from the ear during sleep, but begins to flow afresh as the patient wakes up. This fact affords striking confirmation of the hypothesis advanced in the present paper.

² In order to guard against possible misapprehension, I would distinctly say, that no relation of cause and effect between the two circumstances is implied by the above expression. To affirm that any such relationship exists, and much more, to state which circumstance is to be regarded as cause, and which as effect, would be rash in the present state of our knowledge. But the concomitance of the two circumstances and their mutual dependence cannot, I think, be denied.

proofs:—First, the amount of oxygen consumed differs with the state of the organ. This is shown by the strikingly different quantities of blood which, during the different states, may be seen to pass from an arterial (or oxygenized) to a venous (or carbonized) condition. Secondly, the products of nervous waste excreted from the body have been found to vary with the degree of mental excitement.¹ Thirdly, we know by experience, that the amount of repose we require is to a certain extent proportionate to the exertion we have undergone.

Now, when the brain is stimulated to action, its affinity for oxygen is increased, or at any rate is especially permitted to come into play. The *vis à fronte* thus developed, causes the oxygenized blood to be drawn very rapidly onwards. The increased afflux of blood produced, necessarily distends the capillaries by mechanical action. Many vessels which, during the unstimulated state of the organ, admitted only the liquor sanguinis, now permit the passage of oxygen-bearing corpuscles, while those through which corpuscles previously passed, now admit them in vastly increased numbers. The quantity of blood, and its velocity, are both increased. The “circulation of function” becomes established, and the most favorable conditions for the mutual reaction of oxygen and tissue are supplied.

The augmented rapidity with which the blood courses through the capillaries, not only directly contributes to the activity of the organ, by promoting the large supply of oxygen, but also probably aids the endosmosis into the vessels of those products of oxidation, which, if not removed, might tend to check the continuance of the process, as we shall presently see. On the other hand, this rapidity of motion is certainly

¹ Some discussion having arisen upon this point, in connexion with the expression of my views upon the subject of sleep in the physiological section of the British Association during the late meeting at Oxford, Professor Draper stated, that he was about to publish an account of a series of experiments he had been carrying on, the result of which fully confirmed the conclusions of Dr. Bence Jones (*Phil. Trans.*, 1847), Sutherland, and others, and placed the above statement beyond dispute. Mr. Milner, surgeon to the county gaol at Wakefield, kindly favoured me by the information, that he could infallibly find out when any prisoner was suffering from any source of trouble or worry, by the amount of phosphates in his urine. This fact, arrived at after the careful observation of the excreta of a large number of men taking the same diet, and performing the same muscular work, is, I think, very valuable.

unfavorable to the exosmosis of nutrient material from the vessels into the tissue. By whatever vital process it may be that fresh material becomes incorporated with the tissue, so as to effect its repair, it is by the ordinary *physical* process of osmosis, that nutrient material passes into the tissue, and the products of disintegration pass into the blood-vessels. Particular affinities may perhaps somewhat modify the results, but we have no reason to believe the principle is other than that well-known one, upon which we can experiment in our laboratories. Now, let a tube of animal membrane (such as a portion of the intestine of a rabbit) be used as the osmometer, and one of the fluids, it matters not which, be made to pass with varying degrees of rapidity through it, the whole tube being immersed in the other fluid. It will be found, *cæteris paribus*, that the more rapidly the fluid passes through the tube, the less is the exosmosis from the tube, and the greater the endosmosis; and, *vice versa*, the more slowly the fluid is made to pass, the greater is the exosmosis, and the less the endosmosis.¹ The application of the principle thus established to the interchange between tissue and blood through the walls of the vessels is obvious; and it becomes evident that the degree of rapidity with which the blood traverses the capillaries forms an accessory, if not an essential, element in the functional activity or nutrition of the organ.

Again, when the stimulus to action ceases to operate, or when, from any other cause, the tendency to oxidation of tissue is diminished, the *vis à fronte* undergoes a corresponding diminution, and the blood that flows onward is lessened both in quantity and velocity. As a necessary consequence, the capillaries (no longer subject to a powerful distending force) reassume, in virtue of their elasticity, their original dimensions. The "circulation of nutrition" supervenes, and the conditions most favorable to the repair of the tissue are supplied. The corpuscles, which if numerous would stimulate to active change, are comparatively few, especially in the minuter capillaries; while the slower rate at which the blood moves favours, as we

¹ My own experiments in confirmation of this statement have been numerous, varied, and most satisfactory. I do not describe them at length, because to do so would unnecessarily break the course of the argument; and further, I have the impression that they are not novel, although I am unable to find, and therefore to quote, any authority on the subject.

have seen, the exosmosis from the vessels of those materials which are requisite for the nutrition of the tissue.

If, from continued functional excitement of the organ, the distension of the capillaries has been unduly protracted, their walls, like all other elastic bodies kept long on the stretch, are slow to recover themselves. Under such circumstances the circulation of nutrition is not readily established. Some explanation is thus afforded of the difficulty we experience in obtaining sleep after excessive mental activity.

The next question proposed for consideration is—What is the proximate cause of the temporary suspension of cerebral activity which follows each period of healthy mental exercise? It cannot be that the whole of the material, ready for oxidation, is exhausted; for let some powerful stimulus to exertion arise, and the action of the brain can be much longer sustained. An answer much more satisfactory is suggested by certain obvious analogies, and supported by several recognised facts. It is well known that, as a general rule, the presence of the products of any chemical action interferes with the continuance of that action. Very many instances are familiar to all chemists. Butyric and lactic acids, unless got rid of almost as rapidly as they are set free, arrest the processes of fermentation by which they are severally produced. To take a different mode of chemical action: If a lighted taper is placed in a closed vessel, it is quickly extinguished by the carbonic acid its own combustion has generated, although abundance of oxygen still remains. Again, the sulphate of zinc, as it accumulates in the cells of the galvanic battery, diminishes the chemical action by which, correlatively, electricity is developed; the action may even be stopped altogether, long before the acid is exhausted. It is needless to multiply illustrations. The further we examine, the more universally is the general principle found to hold good. Now we know that the same laws of chemical action prevail in the living body as out of it, and we are necessarily led to the conclusion that the products of the oxidation of the brain substance, when they have accumulated to a certain extent, whether in the tissue or in the blood, necessarily interfere with the continuance of the process. When the tendency to oxidation is diminished by whatever cause, it is easy to explain, as we have seen, why a change in the character of the

circulation must ensue. But, it may be asked, what proof have we that the products of nervous waste can be formed faster than they are got rid of? We have, at present, no direct proof in this case, it must be admitted; but in the analogous case of the oxidation of muscle the proof is easy. After violent muscular exercise, the products of its disintegration (kreatin and kreatinin, &c.) have been found in largely increased proportion in the tissue.

Again, we know that acids are always inimical to oxidation; and it is probable that the earlier products of the oxidation of the brain substance are acids. If a portion of the brain of an animal be taken, and examined while still almost living, it will be found to possess a neutral or even slightly alkaline reaction; after a short exposure to the action of the atmosphere, it becomes acid. This change in reaction must be due to the products of oxidation. Whether similar products are formed during life, is at present undetermined, but it is at any rate certain that carbonic acid is among the substances first produced. Thus, by the very functional activity of the brain, are generated compounds which interfere with the mutual reaction of oxygen and tissue, and thereby prevent over-exhaustion, and indirectly tend to induce, at the right moment, that state of repose which is essential to repair. This view is supported by the fact that the retention in the body of the products of its waste is almost invariably associated with peculiar lassitude and drowsiness. Such drowsiness is relieved only when the proper excreting organ has performed its office, or when another organ has been stimulated to vicarious action. No physical circumstance, probably, is more essential to clearness of intellect and happy activity of the mind, than a healthy state of the excreting organs. The reason of this is manifest, if the views I have submitted are correct.

It may further be stated, that whatever tends to lessen the mutual affinity of brain-tissue and oxygen, or to prevent their affinity from coming into active operation, may, *within certain limits*, become more or less directly the cause of sleep, provided always that the requisite state of the cerebral circulation can be established. Such causes are to be found, 1st, in diminished susceptibility of the brain-matter itself; 2d, in diminished activity of the oxygen supplied; 3d, in the pre-

sence of certain substances which catalytically check the reaction.

1st. With regard to the first class of causes, there can be no doubt that the constitution of the brain, in common with that of other tissues, differs with the temperament of the individual. No process of analysis can inform us of the nature of this difference, but that it exists we have abundant evidence. The chemical changes associated with, and manifested by, functional activity are much more rapid and energetic in some constitutions than in others. In the sanguine and nervous temperament, all the organs of the body are vigorous in their action; "the lamp of life burns strong and bright;" wakefulness is long sustained and easily preserved, because of the high susceptibility of the brain substance to stimulation and change; and sleep is comparatively short, because the nutritive processes are rapidly performed. In the cold and phlegmatic, on the other hand, the various functions are less actively carried on, the brain is less susceptible of chemical change, oxidation takes place more slowly; "the light of intellect is dim;" wakefulness is maintained with comparative difficulty, and sleep is long continued. Not only does this contrast exist between the cerebral susceptibilities of different individuals, but the experience of almost every one supplies evidence that a similar, though less marked, contrast occurs in the same individual at different periods, and under change of circumstance or habit.

2d. With regard to the second class of causes, the experiments of Dr. B. W. Richardson¹ conclusively prove that the defect may be in the condition of the oxygen rather than in that of the tissue. Dr. Richardson placed some animals in an air-tight chamber, and caused them to breathe over and over again the same oxygen, in the following manner:—The gas, after having been made to traverse the chamber, was purified from ammonia and carbonic acid by means of sulphuric acid and potash, and then reintroduced. The animals became depressed and drowsy, and gradually sank into what appeared to be "a profound and pleasant sleep." Some of them never recovered, but died without convulsions. The brains of those which died were "bloodless." This fact affords striking

¹ Paper read before the British Association at Oxford.

confirmation of the views I have expressed. Now whether it be, as Dr. Richardson believes, "that oxygen breathed over and over again" loses "some principle extant in the primitive oxygen which is essential to life," or whether it be that some modification in the condition of the oxygen, whereby it is rendered less active, is effected during its passage through the sulphuric acid and potash, matters not. This much is indisputable, oxygen may lose, under certain circumstances, its activity to such an extent that it no longer effects those chemical changes which are essential to life. When the diminution in activity is carried to a less extent, the vital functions are depressed, but not arrested. We know that, under favorable circumstances, oxygen is to be met with in the atmosphere in its more active condition of ozone; under opposite circumstances, such as prevail in large and crowded cities, where the oxygen is necessarily breathed over and over again, its less active condition may be developed. Such an idea is naturally suggested by the experiments of Dr. Richardson. Thus is afforded some explanation of the depression of the vital powers, and the general sleepiness, experienced in certain localities, beyond what is accounted for by the presence of carbonic acid, variations in barometric pressure, or any other of the circumstances usually quoted.

3d. With regard to the third class of causes, viz., the catalytic action of certain substances, there necessarily exist the greatest difficulty and obscurity. Indeed, the very word catalysis, like many other seemingly "scientific terms," is but a cloak with which we attempt to hide our ignorance. Still it is an established fact, that various substances do, by their presence, variously affect different chemical processes in which they themselves take no part. It may be thus that we are to explain the narcotic influence of certain drugs. We have seen how a somewhat similar explanation may apply to the influence of the products of disintegration formed within the body. I have made numerous experiments with the narcotics in ordinary use (opium, lactuca, hyoscyamus, &c.), for the purpose of ascertaining, if possible, whether the state of the cerebral circulation under their influence resembles that which characterises healthy sleep. The results I have at present arrived at have not been satisfactory. When an animal is asleep after a

moderate dose of a narcotic, it is difficult to say how far the sleep is due to natural causes, and how far to the influence of the drug; and when a poisonous dose is administered, respiration becomes impeded, and, as a necessary consequence, venous congestion of the several organs ensues. Further, we know that the operation of narcotics varies, to some extent, with the constitutional peculiarities of the individual; and much more when they are administered to different animals.

The brain of an animal asleep after the hypodermic administration of one or two grains of hydrochlorate of morphia presented no peculiarity; twelve grains, however, speedily produced symptoms of poisoning, with venous congestion of the brain.

Other causes of sleep less immediate than those already discussed, but not less worthy of attention, arise out of the correlation which exists between the circulation within the cranium and that in other parts of the body.

The vital organs of the body, supplied by the systemic circulation, may be divided into four great groups, viz., the nervous, the muscular, the alimentary (including the liver), and the excretory (including the skin). Now, seeing that the functional activity of each part is, in a measure, proportionate to its supply of blood, it is obvious that the four groups of organs cannot be all in any high degree of activity at the same time, because they cannot all have the requisite amount of blood. One group, stimulated to action, acts as a derivant from the other groups; and thus, the activity of some organs necessarily induces the repose of others. Many illustrations of this principle are more or less familiar. We have, at present, especially to consider whence is derived the large proportion of blood which the brain requires during wakefulness, and what becomes of the excess during sleep; what organs are comparatively quiescent while the brain is in action, and active while the brain is at rest. Now it can readily be shown that an important correlation, both as to circulation and function, exists between the conditions of the brain, on the one hand, and those of the alimentary and excretory organs on the other.

First, with respect to the alimentary organs. After a full meal, the tendency to mental and muscular repose is natural; exertion is difficult and injurious. The lower animals constantly sleep after they have fed heartily. If men of active habits were

to do likewise, they would less frequently become the subjects of dyspepsia, and those other nameless maladies, the consequence of ill-digested and ill-assimilated food. Now, the connection between sleep and digestion depends principally upon the fact that, during the digestive process, the abdominal viscera receive a vastly increased supply of blood. If an animal be suddenly killed, and laid open while digestion is going on, especially during the earlier stages, the liver will be found to be gorged with blood, and the vessels of the alimentary canal to be remarkably full and distended. It is evident that the excess of blood in these parts, due allowance being made for the freshly absorbed material, must be derived from the general circulation. Its special source is shown by the comparatively bloodless condition of the nervous and muscular systems. Such a condition, as we have seen, is incompatible with the functional activity of these systems, and must, therefore, necessitate their repose. If, however, these systems be stimulated to action, the strong current of the circulation is in some measure diverted, as it were, from the digestive organs; and these, no longer receiving the requisite supply of blood, inefficiently perform their office; digestion is delayed, and perhaps not properly accomplished at all. It has been suggested¹ that "the circulation of imperfectly assimilated matter in the blood," and "the pressure within the encephalic vessels, increased by the pressure of the distended stomach upon the abdominal vessels," may contribute to "the drowsiness which follows a full meal." So also the impediment to respiration consequent upon engorgement of the stomach may have some effect. But these and other similar circumstances can only occur occasionally; the two last-mentioned could only arise after a glutton's meal. When such circumstances do occur, they tend to produce torpor

"...ian sleep, although they may perhaps indirectly favour prevention of this latter condition by rendering the brain inactive to those various influences which might otherwise excite it to activity, and thus preserve wakefulness.

The above explanation of the connection between sleep and the digestive process is fully borne out by observation; that it is a correct explanation, therefore, can hardly be doubted; and a sufficient one in most cases will, I think, be allowed.

¹Carpenter's Art. "Sleep," 'Cyclopædia of Anatomy and Physiology.'

The practical bearing of this view of the subject is important and manifest. The following passage from Sir H. Holland's 'Chapters on Mental Physiology' (article "Sleep") may be quoted in illustration and support of the opinions above expressed : "The interval of four or five hours between the heaviest meal of the day and the time of going to bed is by no means that most favorable to sound rest. The early stage of digestion is passed over, during which there is a natural tendency to repose ; and we seek it at a time when the system, as respects the influence of food, is taking up again a more active state . . . The old method of supper at bedtime, in sequel to dinner in the middle of the day, was better in regard to the comfort and completeness of rest at night ; and the habit of good sleep may often be retrieved by adopting a plan of this kind, when even anodyne has failed of effect The connexion of digestion with sleep is so important and unceasing, that we have every cause to infer some relation as to time between the two functions, better fitted than any other to fulfil healthily the purposes of both. This it is the business of the physician to ascertain ; and the knowledge so gained may at least become an important aid in the treatment of disease."

Again, hunger is well known to be a frequent cause of wakefulness, and the satisfaction of hunger is as frequently followed by an almost irresistible inclination to sleep. The popular objection to "going to bed with an empty stomach," especially after mental exertion, is not only suggested by everyday experience, but is shown to be well founded by the above physiological considerations. The stimulus to the stomach afforded by any small portion of food, a biscuit or a glass of wine even, taken before retiring to rest, will often serve to cause the current of the circulation to set, as it were, towards the digestive organs, instead of towards the brain. By such simple means, hours of sleeplessness may in many cases be avoided.

We have, in the next place, to consider the state of the excretory organs and skin during sleep. Now, there is reason to believe that increased supply of blood corresponds to increased functional activity with these organs, as well as with those of the nervous and muscular systems. At the same time, it is clear that the reason of this correspondence must be somewhat

different in the two cases. We have abundant evidence that the kidneys, the intestines, and the skin actively perform their several offices during the repose of the brain. It can be shown, also, that they receive a proportionately large supply of blood.

First, with regard to the kidneys. The comparative functional activity of these organs must be estimated, not by the amount of *water* which is poured out, but by the amount of *solids* which are excreted. Now, the quantity of solids contained in the morning urine is well known to be very large, and to contrast remarkably with the small quantity contained in the copious limpid urine which is passed during periods of mental excitement. Again, the kidneys of an animal killed suddenly whilst asleep may be seen to be very turgid with blood, as compared with those of an animal killed in a similar manner whilst in a state of activity.

Secondly, our knowledge of the excretory functions of the intestinal canal is very limited. But whatever may be the precise nature of these functions, and by whatever parts they may be especially performed, it is certain that they are carried on, and perhaps most perfectly accomplished, during sleep; for in the morning it is usually found that fæcal matter has been accumulating during the night, in the rectum and lower part of the colon. Evacuation takes place as soon as the lower bowel has been stimulated to peristaltic action, by food in the stomach, or some other cause. Such, at least, is the daily experience of most healthy individuals.

Thirdly, with regard to the skin. There are several reasons for believing that, during sleep, the cutaneous and sub-cutaneous structures are largely supplied with blood; and that thus the encephalic circulation is influenced to a considerable extent and in a very important manner. During sleep, the heart's action and the respiratory movements are less frequent, and the processes of oxidation by which the animal heat is developed are at their minimum. To these causes we must attribute the general reduction which has been observed in the temperature of the body during the night. If due allowance be made for this general reduction, and for two or three other sources of error arising out of the temperature of the atmosphere and its relation to perspiration, it will be found that the warmth of the surface is greater, by $1\frac{1}{2}^{\circ}$ to 2° , during sleep than during those

periods of wakefulness when the brain is active, provided in the latter case no causes are in operation which give rise to increased heat of skin. My observations on this point have been made upon persons confined to bed ; so that differences of clothing, and effects of position, &c., are excluded almost entirely as possible sources of error. This connection between warmth of the general surface of the body and sleep is practically familiar to all. The experience of almost every one can testify, that whatever promotes this natural warmth favours sleep, and that any cause of chilliness tends to preserve wakefulness. Whether "we get warm as we go to sleep," or whether "we go to sleep as we get warm," matters not. The concomitance of the two circumstances is equally expressed and acknowledged. Now, warmth of skin must necessarily be associated with the presence of a large quantity of blood in the cutaneous vessels. Any external source of warmth (provided it be not excessive) favours sleep, by inducing a flow of blood towards the surface ; and cold preserves wakefulness, not only by giving rise to a sense of discomfort, but more directly by causing the various structures of the skin to contract, and thus driving towards the internal organs the blood which would otherwise be circulating in the superficial parts. It need scarcely be remarked, that the torpor produced by exposure to extreme cold is a condition altogether different from healthy sleep. Again, the excretory functions of the skin are carried on more actively during sleep. The observations of Sanctorius, Keill, Edwards, and others, show that the perspiration of sleep is not only more copious, but that it partakes more of the nature of an excretion, and less of the nature of mere aqueous transudation, than the perspiration of wakefulness. This circumstance, equally with the warmth of surface, indicates the presence of an increased quantity of blood in the cutaneous vessels during sleep. We have not only these and other indications that an important relation exists between the encephalic and cutaneous circulations, but, further, the practical application of our knowledge of this relation affords proof of its existence. It must have happened to almost every hard and anxious student, and to others who have worked on too far into the night, to have gone to bed with flushed cheeks and throbbing temples, but cold, clammy feet and hands, and with a general pallor and sense of

chilliness over the surface of the body. Under such circumstances, sleep is impossible. Experience testifies to the fact, and the anatomical conditions already sufficiently indicated afford the explanation. In such a case, the very desire for sleep helps to preserve wakefulness, and it is long before the essential conditions supervene without remedial agency. Opium is undesirable, for many reasons. Moderate doses are useless, and large doses are liable to produce injurious after-effects. But a warm bath, or even immersion of the feet and legs in hot water, acts like a charm. The explanation is obvious. An increased quantity of blood is drawn to the surface of the body, even to the extremities, and proportionate relief is given to the long-distended vessels of the brain. Such assistance having been afforded artificially, the change in the circulation is accomplished naturally. The characteristic condition is quickly established, and sleep of necessity ensues. In a similar manner may be explained the sleep-inducing powers of Junot's atmospheric boot, and of Darwin's centrifugal bed.

Much more might be said respecting the correlation between the circulation in the cranium and that in other parts of the body. Many more illustrations might be quoted in support of the opinions expressed, and many practical suggestions might be deduced. Enough, however, has been advanced, I think, to indicate clearly that, apart from any direct nervous influence, the brain's activity and repose affect, and are affected by, the activity and repose of certain other organs, and that this mutual reaction arises, in great measure, out of the relation of the conditions of the brain and of these other organs to the general balance of the circulation.

I have now stated definitely the idea which, as far as I am able to judge, ought to be associated with the word "sleep." No one will question the advantage, not to say the necessity, of associating a definite idea with every word in the language of science; and whether the definition submitted in this particular case be considered worthy of acceptance or not, it will be readily admitted that the facts and reasoning advanced in the present essay are not only perfectly consistent with such a definition, but that they do much towards establishing its correctness.

I have, further, described the state of the cerebral circulation

during sleep as contrasted with that which prevails under different degrees of cerebral activity ; indicated the correlation of the encephalic circulation with that in certain other organs ; and submitted an explanation, supported by many facts, of the connection which exists between the particular condition of the circulation through the brain and the excitement and waste of the organ, on the one hand, and its functional quiescence and repair on the other. I have also suggested, somewhat hypothetically, the proximate cause of that repose which naturally follows each period of healthy activity. Thus is accomplished, but too imperfectly, the object of my present paper. I cannot conclude, however, without pointing out the manner in which the phenomena of dreaming support the general theory I have advanced of the nature of sleep ; for no essay upon sleep, however brief, is considered complete without some reference to those remarkable states of the mind (or of the brain) when the will is in abeyance, and the consciousness is awake—not to material objects acting through the senses—but to mysterious processes of internal change ; states in which the faded pictures, photographed as it were in the memory, are restored, and, it may be, distorted and displaced by the imagination. And further, no hypothesis of the anatomy of sleep can be received which is inconsistent with what is known of dreams and dreaming.

Now, dreams indicate a partial or incomplete activity of the nervous centres, and are associated with those states of the cerebral circulation, which have been mentioned as intermediate between the states which respectively characterise perfect repose and perfect activity or wakefulness of the brain. It has been repeatedly asserted that dreams occur only during imperfect sleep. It appears to my own mind, that this must necessarily be true, if the idea of sleep which I have stated is correct ; and that, for the following reasons : In the first place, dreaming indicates activity of, at any rate, certain portions of the brain ; for consciousness is no longer entirely suspended, and impressions upon the organs of sense manifestly affect the changes in the nervous centres. The *psychological* characteristics of perfect sleep, therefore, are no longer present. In the second place, the *anatomical conditions* are different during dreaming from what they are during perfect sleep. This is

proved by the case of the woman of Montpellier, already cited ; also by the two facts, taken in conjunction, that “dreams usually occur in the moments between sleeping and waking,” and that between the state of the circulation which characterises perfect activity, and that which characterises perfect repose, there are intermediate conditions, which are of necessity associated with intermediate conditions of the various faculties. Again, in some parts of the brain the circulation of function may prevail, while in other parts the circulation is of that kind which is most favorable to nutrition. Thirdly, we may conclude that an essential *physiological* difference must exist between the sleep of utter unconsciousness and the partial sleep disturbed by dreams, because, the more continuous and uninterrupted is our dreaming, the less refreshing is our sleep ; in other words, the less complete and perfect has been the repose of the brain, the less capable is it of vigorously re-assuming the exercise of its various functions. Thus, local or general activity of the cerebral circulation, greater than that which is associated with entire suspension of function, characterises that peculiar condition of the brain’s functional activity which we call dreaming. And since dreaming indicates a certain amount of cerebral activity, no sleep can be perfect in which dreaming occurs.

From what has been now advanced, I think the following conclusions may be fairly deduced.

First. Pressure of distended veins upon the brain is not the cause of sleep ; for during sleep the veins are *not* distended ; and when they are, symptoms and appearances arise which differ from those which characterise sleep.¹

Secondly. During sleep the brain is in a comparatively bloodless condition ; and the blood in the encephalic vessels is not only diminished in quantity, but moves with diminished rapidity.

¹ It has been suggested that the injection of the conjunctivæ during sleep affords an argument in favour of the venous-distension hypothesis. But it must be recollected, that during sleep the eyelids are closed, and the mucous membrane, instead of being exposed to the air, is covered : evaporation is thus prevented, and warmth kept in ; as a necessary consequence, the blood-vessels become relaxed, and full of blood. A similar state of the conjunctivæ may be induced during active wakefulness, by keeping the eyes closed for an hour or two ; and further, one of the symptoms of insomnia is an injection of the conjunctivæ.

Thirdly. The condition of the cerebral circulation during sleep is, from physical causes, that which is most favorable to nutrition of the brain-tissue; and, on the other hand, the condition which prevails during waking is associated with mental activity, because it is that which is most favorable to oxidation of the brain-substance, and to various changes in its chemical constitution.

Fourthly. The blood which is derived from the brain during sleep is distributed to the alimentary and excretory organs.

Fifthly. Whatever increases the activity of the cerebral circulation tends to preserve wakefulness; and whatever decreases the activity of the cerebral circulation, and at the same time is not inconsistent with the general health of the body, tends to induce and favour sleep. Such circumstances may act primarily through the nervous or through the vascular system. Among those which act through the nervous system, may be instanced the presence or absence of impressions upon the senses, and the presence or absence of exciting ideas. Among those which act through the vascular system, may be mentioned unnaturally or naturally increased or decreased force or frequency of the heart's action.

Sixthly. A probable explanation of the reason why quiescence of the brain normally follows its activity is suggested by the recognised analogical fact, that the products of chemical action interfere with the continuance of the action by which they are produced.

Much might be added in further elucidation of the principles enunciated in the present essay, and much of practical application might be adduced. Such considerations, however, I leave to a future opportunity.

SOME CASES OF HYDATID DISEASE.

By S. O. HABERSHON, M.D.

MANY instances of hydatid disease have been recorded in former numbers of the 'Guy's Reports;' and the following cases are added, as illustrating some points connected with their pathology and treatment. The researches of Livois, Von Siebold, and of Küchenmeister, have given increased interest to the etiology of hydatid disease, by showing its connection with tape-worm; but these considerations we do not at present touch upon. The diagnosis of hydatids is often exceedingly obscure; and when the character of the disease is well ascertained, the best mode of treatment is anxiously discussed, as to whether a cyst which gives no inconvenience, and does not produce any disturbance in the ordinary functions of life, should be allowed to increase; or whether the risk of future fatal rupture counterbalances the danger of immediate operative interference. We shall be glad if the adjoined cases serve in any measure to guide the treatment in doubtful instances: two of them have previously been published in the 'Medical Times and Gazette;' but we thought them of such interest, that we have ventured to narrate them again, as well contrasting with those under our own care.

CASE 1.—*Hydatid disease of the liver; rupture into the pleura; death.*

(Reported by Mr. E. W. VALENTINE.)

James S—, æt. 31, was admitted into Guy's Hospital, May 14th, 1856, under my own care. He was a milk-man,

who had resided in the Hackney Road; a tall healthy-looking man, of rather sallow complexion, and of intemperate habits. He had previously been in the hospital, under Dr. Hughes' care, in February, 1855, and the following report was then made by Dr. Brown: "There was no history of malignant disease, neither had he ever been troubled with worms (his brother had been so affected). Some time previously he had syphilis, and had been subject to winter cough. He had been intemperate in his habits. Ten months before his admission he first noticed that, after walking or making any exertion, he experienced a dull aching pain across the back, about the upper lumbar vertebra; but he felt no other inconvenience, and continued at work. One month afterwards, he perceived a projection from the ribs, about two inches below the right nipple; and shortly found that his skin was slightly yellow, but his health continued tolerably good; he had no pain excepting in the back, and remained at his employment. The slight jaundice continued for about three months, during which time the swelling slowly increased; but afterwards all pain left him, and the tumour apparently ceased to grow. At Christmas in 1854 the pain returned in his back, and the swelling increased more rapidly; he then found that his breath was much shorter on making exertion, and after a full meal there was an uneasy sensation of over-distension. He then went to the German Hospital, and after the use of iodide of potassium the tumour diminished slightly in size. He had never had any pain in the right side or shoulder; the bowels had been regular, and the evacuations of natural colour; and the only complaint was that of a dragging pain in the back on exerting himself. In his right side was a tumour, occupying the right hypochondriac and epigastric regions, and extending to the left hypochondriac, umbilical, and right lateral regions; below, and nearly level with the umbilicus, a curved edge could be traced, apparently that of the liver; above this edge a rounded, smooth, tense swelling was felt, extending upwards beneath the cartilages of the ribs. The surface of the tumour was smooth; but on close inspection, lines corresponding in position to the semilunar and transverse lines of the right rectus muscle were seen. The whole of the region thus distended was dull on percussion, except quite at the lower part, where there was tympanitis,

Deep-seated distant vibration was felt over the upper part of the tumour; neither auscultation nor succussion gave any sign; respiration was chiefly diaphragmatic, and the whole of the tumour moved equally downwards during inspiration. The rest of the chest was duly resonant on percussion. Respiration was normal on the left side, and on the upper part of the right, but no respiratory murmur was heard below the nipple in front; posteriorly, however, vesicular breathing was heard nearly as low on the right as on the left side. Heart-sounds normal. Pulse 78, small and regular; urine sp. gr. 1025, not albuminous, and free from the elements of bile. Skin normal; legs not œdematous. On February 20th, 1855, he was presented unrelieved."

After leaving the hospital, he returned to his employment, and continued to follow his occupation till readmitted in May, 1856. The tumour had enlarged considerably since he had left the hospital, growing for two or three weeks, and then ceasing for a time; but during the last three weeks had grown more rapidly than it had done for three months previously. He complained of dull aching pain in both loins, but more on the right than on the left side, extending downwards over the right buttock as low as the junction of the middle and lower third of the thigh. When taking exercise, his breathing became much interfered with; and after eating a full meal, an uneasy sensation of over-distension was produced; the skin was of a yellowish, tawny colour. If he walked about, his legs and feet swelled slightly. The tumour extended on the right side from the fourth rib as low down as the umbilicus, where a defined margin could be felt. About one to two inches to the right of the ensiform cartilage was a rounded, smooth, tense swelling extending beneath the ribs; fluctuation was here quite distinct, and on placing the hand over the same part a distinct grating sensation could be felt during inspiration. The veins passing over the tumour were enlarged. There was considerable pressure on the right lung, but otherwise the thoracic viscera were healthy. The tongue was clean, the appetite good, the bowels were regular. His general health appeared to be very little interfered with. Strong electric shocks were passed through the tumour several times during ten days, and produced slight ecchymosis of the skin. A consultation was then held

as to the propriety of drawing the fluid from the cyst ; but the freedom from all urgent suffering in the state of the patient at that time, and the danger of such an operation, led to the decision that no operative interference should be then recommended ; and he left the hospital unrelieved.

He was afterwards admitted into another of the metropolitan hospitals ; on February 16th, 1857, he was taken suddenly worse, and applied to Dr. R. U. Wallace, who has kindly favoured us with the following report : “ I was first called to him when he was suffering considerably from dyspnœa, the whole of the right chest was dull on percussion, and he appeared to breathe with the left lung only. He continued to get worse ; and on February 18th, in the evening, I tapped him in Dr. Gull’s presence, and removed seven pints of a reddish-brown and rather turbid fluid. By this he was greatly and immediately relieved. Dyspnœa began to come on again in a day or two, after which it gradually increased ; and on February 23d I again tapped him, and six pints and a half of a similar character were removed. All went on comfortably for a week, when the difficulty of breathing again recurred ; it became gradually worse, and necessitated the removal of fluid again on March 7th, but this time to the extent of eight pints and a half ; the fluid was rather more opaque than the last, and quite free from odour. He was then again comfortable for eight or nine days ; but on March 19th, the dyspnœa being again urgent, paracentesis was performed to the extent of eleven pints and a half ; the fluid was rather more turbid, but still free from odour. He then remained easy for four or five days ; and on March 28th, ten pints and a half more of fluid were removed, having the same character as on the previous occasion. This eased him for three or four days, after which time he began very gradually to become worse as regards his distress of breathing, until the 14th of April, at three a.m., when he began to expectorate a great deal of yellowish-white curdy sputum, looking somewhat like paste and water badly mixed ; at ten a.m. he had expectorated a pint of this fluid, and at ten p.m. he had coughed up three pints. This relieved his breathing, but the continued coughing and expectoration wearied him greatly. He complained of no pain. On the morning of the 15th (nine a.m.), the expectoration had amounted in quantity (alto-

gether) to four pints and a half. The next morning it had reached eight pints. He went on coughing and expectorating till half-past two a.m., when he fell asleep, and was found dead at three a.m. Altogether he expectorated eleven pints of fluid; no cysts were, however, detected in it; about another pint was thrown up at his last moments. After each operation opiates were given, and occasionally chloric ether, ammonia, &c.; and he was permitted to partake largely of fluid nourishment. At the post-mortem, thirteen hours after death, the left lung was found to be in a healthy state, with pleuritic adhesions. The right lung was compressed and indurated, and much reduced in size; the whole surface of the right pleural cavity was roughened and granular in appearance, and in it was found a hydatid cyst of large size. There was an opening in the diaphragm rather larger than a crown piece, communicating with a large cyst in the right lobe of the liver, which latter was adherent to the diaphragm. In the pleural cavity, and in the hepatic cyst, there were about four quarts of pus and serum. The kidneys were healthy. The heart large and very fatty on its surface. Death took place nearly three years after the occurrence of the first symptoms."

Remarks.—The diagnosis in this case was not difficult; the situation of the hydatid growth on the anterior and superior part of the right lobe of the liver rendered it prominent, and capable of careful examination. It was seen to be slowly enlarging, and at the time of his second admission was of considerable size, but did not produce much distress, or materially interfere with his ordinary avocations. It was regarded as unlikely that a cyst of such large size would undergo degenerative changes and contract, and the dangers of rupture into the pleura or peritoneum were discussed; favorable cases of discharge of hydatids through the bronchi were instanced, and the imminent risk to life of drawing off the contents of the cyst were dwelt upon. The result of the favorable cases had been sometimes very doubtful for a time; one of these, under the care of Dr. Owen Rees, is recorded in the 'Guy's Reports' of 1848. The absence of great distress, and even of inconvenience when at rest, his ability to perform his ordinary labour, and the considerations just mentioned, led to the decision not to draw off the contents of the cyst at that time, either directly

or by the application of potassa fusa ; but the subsequent termination of the case, by rupture into the pleural cavity, appears to indicate that a more prudent course, and one of really less danger to the patient, would have been at once to empty the cyst ; and we think that in another instance of this kind, if the diagnosis were equally clear, we should recommend operative measures, without waiting until more urgent symptoms arose. This patient was directed to reapply to the hospital if he experienced pain or distress, but postponed the proffered help till too late. In this case electricity was used, not by means of needles introduced into the cyst, but on opposed sides of the tumour ; no beneficial effect was, however, observed to follow. In connection with disease of this kind, it must be borne in mind, that empyema is sometimes simulated, paracentesis thoracis performed, and pus evacuated containing hydatids, thus affording the first indication of the real character of the disease ; such an instance occurred in the practice of the late Dr. Hughes.

CASE II.—*Hydatid disease of the liver ; contents evacuated by repeated operations. Recovery.*

(This case will be found reported in the 'Medical Times and Gazette,' in 1856.)

Henry B—, æt. 36, a labourer in the docks, living at Stepney Green, was admitted under the care of Dr. Babington and Mr. Cock, August 24th, 1853. He had been for twelve years a soldier in India, and had very good health, with the exception of an attack of jungle fever, until three years ago, when he was seized while in the riding-school with violent pain in his back. The pain did not last long, and he thought no more of it till three weeks afterwards, when he noticed a small swelling about an inch above the umbilicus ; and he was soon afterwards troubled with nausea every morning, but without vomiting. The tumour gradually increased, and became painful, so that he could not bear the weight of his sword and pistol. He then remained in hospital for eighteen months ; blisters, leeches, and tartar emetic plasters were applied to the abdomen, but he derived no benefit. The swelling gradually increased, and was attended with severe pain. As soon as he left the hospital he was sent to the Himalaya Mountains ; he did not suffer quite so much from nausea whilst there, but the tumour gradually increased. He remained in the mountains

four months, and then returned to Calcutta ; and two months later he was discharged from the service, and sent home. He arrived in England fourteen months before admission ; his health was improved ; and although his abdomen was much enlarged, he did not suffer inconvenience, and had no pain. He obtained employment at the London Docks, where he continued till three weeks prior to his application at Guy's Hospital ; the great size of his abdomen, however, and the pain in his loins and shortness of his breath, obliged him then to discontinue work. The abdomen was full and tense, rounded and quite symmetrical, in appearance resembling ovarian dropsy. The margin of the tumour could be felt on the left side between the liver and the ribs, but on the right it appeared to be continuous with the liver. His general health was good ; and he experienced no inconvenience, except on exertion.

On September 1st Mr. Cock saw him, in consultation with Dr. Babington, and it was agreed that the tumour was probably hydatid. It was decided that a small exploring trochar should be passed ; half a pint of clear fluid escaped, of sp. gr. 1005, neutral, and not coagulable by heat. On the 2d, he felt as before, but the abdomen was not quite so tense. On the 10th, Mr. Cock again passed a small trochar, and drew off four pints of clear, colourless fluid, of sp. gr. 1008, and like the former. 11th. The abdomen was much reduced in size ; the patient felt prostrate, and ℥viiij of wine were allowed. 14th. Felt much relieved, the abdomen smaller, and quite free from pain. 19th. Mr. Cock drew off three pints more of fluid, rather turbid, and of a light-brown colour. On the 27th, the tumour had not increased in size, and the general health of the patient was good. On October 6th, two pints more were drawn off ; on the 17th, half a pint ; after the 27th, a small quantity was drawn off every third day, and the cyst washed out with warm water ; and on the 7th of November several small hydatids, presenting hooklets of the *ecchinococcus*, came away with the fluid, which gradually decreased. November 14th. Hydatid cysts in large numbers continued to escape ; the fluid was still in considerable quantity, quite purulent and fetid. 21st. In order to give exit to the retained cysts Mr. Cock enlarged the external opening, by cutting upwards with a probe-pointed bistoury. A very large canula was afterwards introduced, and

enormous numbers of broken-down cysts escaped. The patient was feeble, and complained of much pain in the shoulders and other joints. He was ordered iodide of potassium with iodide of iron. 31st. To remedy the extreme fetor, an injection of chloride of soda was employed. His health slowly improved, and on January 1st the cavity had much diminished in size, but the discharge was very fetid. In February and March considerable improvement took place, and in April he left the hospital, a small suppurating cavity still existing. Two months afterwards he was again seen by Mr. Cock; recovery was then complete; the sinus had closed, and a certain extent of induration beneath its site was all that remained.

Remarks.—The case of this patient must be considered a favorable one. The symmetrical appearance of the abdomen was different from that usually observed in hydatid disease of the liver; but the pain produced on exertion incapacitating him from obtaining a livelihood, was a cogent reason for attempting the evacuation of the cyst. There was no evidence of structural hepatic, thoracic, or renal disease; and it was determined to draw off the fluid, first using a minute exploring trochar. The plan adopted by Mr. Cock was that of not removing the whole of the fluid at once, but by repeated operations to remove small quantities at a time; in this way contraction slowly took place. The contents of the cyst did not suppurate for several weeks, the fluid gradually diminished in quantity, and the patient left the hospital perfectly well. There was no evidence of any peritonitis following these repeated operations. Dr. Budd records, in the ‘*Medical Times and Gazette*’ of May, 1860, a plan of evacuating hydatid cysts without allowing the entrance of air; and, by destroying the pressure of fluid in the cyst, causing the death of the entozoa; namely, by pumping out the fluid, rather than allowing it naturally to exude. The method adopted in this case partially fulfilled a similar purpose.

Acute peritonitis is one of the dangers of puncturing cysts of this kind; but more frequently, as far as we have observed, the danger of secondary suppuration is still greater. If the cysts have already suppurated, the general health of the patient is much more likely to sympathise, and prostration, or a typhoid state, be the result; but even then it is most desirable to pre-

vent, if possible, decomposition of the purulent contents. In Case iv the cyst opened into the bile-ducts, suppuration and decomposition took place, and gaseous products were apparently generated, so that a tympanitic state of the cyst existed; thus showing that exclusion of the external air is not a certain preventive against purulent decomposition.

CASE III.—*Hydatid disease of the liver; pressure on the vena cava. Death.*

Elizabeth L—, æt. 31, a married woman, of regular and industrious habits, was admitted into Guy's Hospital under my care, February 8th, 1860. She was rather stout, but her countenance was thin, and expressive of much anxiety. About five years ago she had several miscarriages, and a year later began to feel ill, at first from pain in the bowels, afterwards in the right side. Since that time her health had failed. On admission into Guy's Hospital there was no evidence of cerebral or thoracic disease, except that slight bronchial râles were observed at the base of the left lung; no cough nor dyspnœa were present. The abdomen was enlarged, slightly tympanitic, and the vessels on the surface of the lower part of the chest and upper part of the abdomen were also enlarged; the spleen could not be felt; but the liver was very much increased in size, extending nearly to the umbilicus. Menstruation had not occurred for two years; the legs were slightly swollen. A week after admission, on February 15th, she appeared to be affected with slight bronchitis; the pain in the right side, from which she had so long suffered, was more severe; over the lower ribs, on the right side, there was some rhonchus and dulness, and diminished resonance of the voice; the liver was as large as before, and no inequality could be detected on its surface; the abdomen was resonant. On the 25th, the pain in the right side was severe, and the bronchitis more distressing; the face was congested; rhonchus on the left side more extensive; the pulse compressible. On March 7th the dyspnœa was urgent, the bronchial râles general; the abnormal distension had increased, and she was scarcely able to lie down; the countenance was congested, and had an anxious expression. 15th. There was much less dyspnœa, and she felt relieved; the bowels had been freely acted on; the

liver, however, had enlarged rapidly, the left lobe was much more distinct, and it was thought that a rounded mass could be felt at the *scrobiculus cordis*; the superficial veins were more enlarged, and fluctuation in the abdominal cavity was distinct. 21st. Liver still more enlarged, inequalities on its surface could be felt; the distress of the patient was greatly aggravated; the right side of the abdomen was œdematous, the right leg swollen, the cough troublesome, the face more congested. April 2d. The obstruction to the venous circulation was now very marked; the legs were œdematous, but the right was more so than the left; the abdomen was also distended, and from the patient lying towards the right side, the superficial parts on that side became very œdematous; there was much pain and tenderness on the right side, but there was less dyspnœa. No defined growth could be felt in the liver, which was felt anteriorly to be more uniformly enlarged. The left foot had been exceedingly painful from tension of the skin; Mr. Stocker had directed it to be punctured, but the skin had ulcerated on the dorsum of the foot, and was in several parts almost of a black colour. The pain became excessive, and she was evidently becoming rapidly prostrate. She died on April 3d.

Opium and stimulants had afforded partial relief, and, at an earlier period, cupping to a few ounces between the shoulders, and free purgatives had mitigated the urgent dyspnœa.

On Inspection.—The legs and abdomen were very œdematous; the diaphragm was pushed as high as the second rib on the right side; there was some effusion into the pleura on the same side, and the lung was much compressed, but at the lower part several lobules were gray and consolidated. The left lung, and the heart were healthy. The peritoneum contained several quarts of serum, and the intestines were moderately distended. The liver was enormously enlarged; its right lobe reached below the umbilicus, and the left into the left hypochondrium; its surface was somewhat granular and nodulated, pale in patches, and fatty in structure; in some parts much congested. On the anterior and lower surface, there was nothing to indicate hydatid tumour or cancer; but on withdrawing the tumour from the diaphragm, an enormous cyst was discovered projecting from the upper surface of the right lobe at its posterior part, pushing the diaphragm upwards as

high as the second rib. The weight of the liver, with its contained cysts, was nineteen pounds fourteen ounces; the cysts were three in number, containing together eleven pounds of clear, brilliantly crystalline fluid; they had irregularly excavated the interior of the gland, and were approximated, so that when turned out, a single irregular excavation was left. The cysts contained very numerous hydatid cysts; and echinococci were present in immense numbers upon the granular inner surface of the enveloping large cyst. The spleen was slightly hypertrophied; the kidneys and gall-bladder were healthy. The intestines were healthy; they contained fluid *fæces*, but no entozoa.

Remarks.—The diagnosis in this case was obscure, for the cyst did not reach the anterior surface of the liver, and did not present the rounded and resilient tumour so generally observed. On admission, no ascites had formed. She had pain from the large size of the abdomen, and slight dyspnœa from the encroachment on the thoracic viscera; but these symptoms had gradually come on without much suffering, although her health had for four or five years failed.

There was no evidence of cardiac or bronchial disease to account for enlargement of the liver secondarily. Jaundice was absent during the whole progress of the case; and the condition, also, of the urine and of the evacuations, showed that no pressure on the bile ducts, and no impediment to the free discharge of bile, existed. The habits of the patient, and the history, as well as the symptoms, opposed the idea of enlargement of an inflammatory kind; nor was there anything to lead to the supposition of hepatic suppuration. Lardaceous conditions of the liver are generally associated with anæmia; but the extent of anæmia in this case, when first admitted, did not bear out such an idea. To decide between the pressure of cancerous growth and other tumours was more difficult; inequalities on the surface of the liver could be felt after she had been in the hospital several weeks, and were shown after death to arise from contraction of the anterior surface; and it is well known, that a very large portion of the liver may be infiltrated or encroached upon by cancerous deposit without the production of jaundice. Symptoms of pressure upon the inferior cava became well marked by the enlarged superficial

abdominal veins, the œdema of the legs, and effusion into the peritoneum. The skin of the feet at last became exceedingly tense, superficially ulcerated, and intensely painful; and added very greatly to the suffering of the closing hours of life. An attack of bronchitis, which came on soon after admission into the hospital, produced increased obstruction and much dyspnœa. The rapid increase in size, however, of the liver, and its pressure upon the diaphragm and lung, were the principal causes of the respiratory embarrassment. On the inspection the diaphragm was pushed upwards as high as the second rib. Cupping between the shoulders to a few ounces, and purgatives, afforded more relief to the dyspnœa than any other measures. The size which the cyst attained was very great, holding eleven pints of fluid, or nearly a gallon and a half; but it was of crystalline clearness, and free from any discoloration or admixture of bile. As a termination of hydatid disease, pressure on the cava and diaphragm, and impeded respiration and circulation from that cause, is not common, but a very similar case is recorded by Dr. Budd. The cyst could only have been punctured anteriorly by passing through a thick layer of hepatic tissue; and although M. Leudet, in a very interesting pamphlet on this subject, maintains that this should not necessarily prevent operative measures being performed, few who could have seen the liver after its removal, would have thought it wise or prudent to have passed a trochar through such a layer of congested glandular structure.

CASE IV.—*Hydatid disease of the liver; cyst extending into the common bile-duct; suppuration; jaundice; peritonitis.*

(*From the Report of Mr. C. HILTON FAGGE.*)

Hiram B—, æt. 50, was admitted January 11th, 1860, under Dr. Barlow's care; he was a man of tolerably temperate habits, residing in the Westminster Road. Till seven years ago his general health had been good; he then had an attack of jaundice, with symptoms resembling those for which he was admitted, and was ill for a month. Nine weeks ago he began to lose appetite, had nausea, but no vomiting; the bowels

were costive, and he suffered from headache. Three weeks later, pain across the upper part of the abdomen came on, and he was confined to bed; at the same time he had rigors, and cold sweats followed by febrile symptoms, and by jaundice with dark-coloured urine, and occasionally clayey stools. The pain remained for a few hours, then subsided; but the abdomen continued to be very tender. For more than a week before admission, there had not been any pain in the abdomen, nor rigors, and the jaundice had much decreased. He was a large man; the muscles were flabby, and had wasted; the skin and conjunctiva were *yellow*; the countenance was anxious; the breath sweet; the tongue pale. The lungs were healthy; but the impulse of the heart could scarcely be felt, and the sounds faintly audible; pulse 117, but very compressible. The abdomen was large and full; the veins on the surface were distinct, but there was no fluctuation. The region of the stomach was distended and tympanitic, the resonance extending upwards beneath the lower half of the sternum and the left lower ribs. The liver was enlarged and free from tenderness; the hepatic dulness extended as high as the fifth costal cartilage, and its sharp edge could be felt two inches below the cartilages. The urine contained biliary colouring matter.

On the 13th he had increased pain in the region of the liver on deep inspiration; there was some vomiting, the pulse was more feeble, and the countenance anxious; he had rigor this morning.

On the 16th he was in much distress, and there was considerable distension of the abdomen.

On the 18th he had a very feeble pulse, 132; vomiting; the tongue dry and furred; he died the same evening.

Inspection was made sixteen hours after death. The abdomen was loaded with fat, and on cutting through its parietes, a considerable quantity of pus poured into the peritoneum; it was found to proceed from a suppurating cyst in connexion with the liver. The cyst was very thin and ulcerated in several places; it had probably given way during life, for there was extensive peritonitis, the serous membrane had lost its smooth shining appearance, and the intestines were united by lymph. On removing the liver, it was found that there were three distinct cysts; the two smaller ones containing hydatids and

some pus ; the largest one, situated in the anterior part of the left lobe, had evidently caused the prominence in the epigastric region during life, and had probably contained air, for there was tympanitis over the part. It contained a large quantity of pus and some hydatids, both ruptured and entire. There was also a portion of thick ragged membrane (hydatid cyst) which was making its way into the common bile duct, and was just appearing at the orifice in the duodenum. That portion of the mass which lay in the common duct was stained with bile, and bile could be squeezed out by its side into the duodenum. The gall bladder was healthy, and contained fresh brown bile. The ducts throughout the liver were dilated, and contained pus and inspissated bile, but the portal and hepatic veins were healthy. The thoracic viscera were healthy, but the largest cyst was making its way through the diaphragm, and would soon have entered the pericardium or the left pleura.

Remarks.—It is probable that in this patient the hydatid cyst had existed in the liver for several years, and had caused the attacks of jaundice from which he had frequently suffered. It had slowly ulcerated its way through into the ducts, and at the time of death a cyst was in the act of passing into the duodenum, somewhat obstructing the passage of bile ; the contents of the cyst were partially removed, suppuration had taken place, and there was great probability that the sac contained air arising from decomposition, for it was distinctly tympanitic during life ; but if this had been the only mischief set up, it is possible that life might have been prolonged, unless more marked pyæmia had followed ; the cyst had also extended to the peritoneum, so as to set up general peritonitis ; and if life had been long continued, the diaphragm would also apparently have been perforated. The time for tapping the cyst had already gone by, when admitted into Guy's Hospital ; and palliative measures only could be of service. In the 'Pathological Transactions' for 1858, Dr. Bristowe records a very interesting case, in some respects allied to the one just detailed ; a man, aged thirty-three, affected with symptoms of hepatic disease, was found after death to have large cysts in the liver containing echinococci. In the right lobe of the liver a bile duct communicated with the cyst ; and secondary abscesses

had formed in the course of the bile duct, according to the opinion of Dr. Bristowe, from pressure.

CASE V.—Hydatid disease of the liver, supposed to open into the duodenum.

(Reported by Mr. ENOCH ROBINSON.)

William M—, æt. 29, was admitted into Guy's Hospital under Dr. Rees' care, September, 1856. He was a married man, of steady habits, who had resided at Twickenham; and he had been in the enjoyment of good health till nine years before admission, when he began to suffer from "bilious attacks" once a month, during which he became very slightly jaundiced, and suffered from vomiting; in about four days the attacks passed off. Five years ago he had a severe attack of jaundice, which lasted three weeks; and four months ago he found that his food did not satisfy him; he lost strength, and in nine weeks severe griping pain came on, which confined him to bed, and was followed by jaundice. The pain continued two or three days. The symptoms were partially relieved, so that he was able to get out, but three weeks before admission he was seized with sudden tearing pain passing down from the middle of the right hypochondriac to the lumbar region; no swelling in the hypochondriac region was then observed, but about a fortnight later he had pain, with swelling, at the anterior and inner part of the right lumbar region on the level of the umbilicus. This swelling greatly increased; he had no vomiting; the appetite was variable, the stools were highly coloured. Mercury had been given so as to affect the mouth severely, and iodine had been applied to the tumour. On admission he was a tall slender man, emaciated, the eyes sunken; the skin jaundiced; there was increased dulness at the lower part of the right side; the upper part of the abdomen was tense; and a large swelling, connected with the liver, extended from the cartilage of the seventh rib to the middle of the lumbar region; the tumour was well defined at its lower part, and painful on pressure; the urine was healthy.

On October 3d, the bowels were acted on freely by castor oil.

On 11th, much pain was felt in the umbilical region.

On 13th, the bowels were again copiously acted on by castor oil, with tincture of opium; a distinct friction sound could be felt and heard at the seat of pain; the pulse was small and rapid.

On the 14th, at ten a.m., he vomited four ounces of pus without pain or straining; and on examination of the fluid a hydatid cyst was found. Fish diet was allowed.

15th.—About a dozen hydatids were discovered in the evacuation this morning; the fæces were scanty and of normal colour; the pulse 100 and feeble; the swelling was less and the patient easier; the region of the tumour was tympanitic. Wine and eggs were allowed.

On the 16th there was less pain, and he was altogether more comfortable; hydatids continued to be discharged with the fæces.

18th.—A large bed sore formed on the left buttock; he was placed on a spring bed, and wine given freely.

On the 20th a few more cysts were discovered.

Oct. 23d.—He vomited about half a pint of watery fluid with some pus, and had slight pain at the time; the vomiting of watery fluid continued till November 6th; he then began slowly to improve, and left the hospital on January 7th, 1857. For a month he remained in a comfortable state, but afterwards pain in the region of the liver came on, and he was in constant suffering; after some weeks he was suddenly seized in the night with pain and collapse, and died in ten days. A large quantity of serum, with lymph, was found in the peritoneal cavity. The liver, stomach, colon, and diaphragm, were matted together; and between the liver, colon, and stomach, was a collection of pus. This abscess had ruptured into the peritoneal cavity, and had evidently been the seat of the hydatids. There were several defined abscesses in the liver, and also supuration of the right kidney; the left kidney was hypertrophied. The precise point at which the hydatids had escaped into the stomach or duodenum could not be discovered.

Remarks.—Although this patient was suffering from well-marked symptoms of hepatic disease at the time of his admission into the hospital, it was scarcely known that the disease was one of hydatid character until the cysts were found in the

vomited matters, and with the fæces. The cyst had evidently suppurated, for pus was vomited; but it could not be well made out during life, and the imperfect inspection after death did not clear up the doubt, as to the course the contents of the cyst had pursued in their discharge; whether by direct ulceration into the duodenum, or by communicating with one of the bile ducts. The patient became exceedingly prostrate, and his life, for several weeks after admission, was despaired of; it is probable that the mercurial salivation, to which he had previously been subjected, tended to increase that prostration.

CASE VI.—*Cancer of the pylorus; hydatid disease of the cellular tissue of the bladder.*

W. A—, æt. 52, a clerk, who had resided at Woolwich, was admitted into Guy's Hospital under my own care, March 28th, 1860. He had enjoyed good health till eight months previously, when loss of appetite and vomiting after food came on; the rejection of food took place either at once or after long intervals. The bowels were constipated. Emaciation had gradually become extreme, and when brought to the hospital it was thought that he would scarcely reach the ward. He, however, rallied, and survived for three weeks. Vomiting did not recur till two days before death. There were no signs of disease of the chest. The abdomen was much contracted; an ill-defined tumour could be felt in the region of the pylorus; and there appeared to be no doubt that he suffered from chronic disease of the stomach. He had not suffered from hæmatemesis, neither did he complain of any pain at the stomach. The diagnosis of cancerous disease was confirmed at the inspection. In the hypogastric region was a tumour reaching as high as the umbilicus, precisely resembling in form a distended urinary bladder; it was dull on percussion, rounded in form, and fluctuation was distinct; it was also readily felt in the rectum. The patient stated that he never experienced any difficulty in passing water, nor had he any pain at the part. A catheter was passed without difficulty, and a few ounces of healthy urine was drawn off. My colleague, Mr. Poland, stated his belief that the cyst was not filled with urine. On *inspection*, the thoracic viscera were

found to be in a healthy state; the peritoneum also was healthy. The stomach was slightly distended, and on drawing it aside, a marked constriction was observed at the pylorus; and several of the glands at the lesser omentum and near the pancreas were enlarged and infiltrated with cancerous product. A firm growth was found to exist at the pylorus, extending into the stomach for about one inch and a half, where it terminated by a rounded, raised, and vascular edge; the valve was quite surrounded by the growth, and the surface was partially ulcerated. The growth had a similar vascular and raised edge on the duodenal aspect, but was there less prominent. The little finger could be passed through the pylorus. The growth was of a yellowish-gray colour, moderately firm, containing succulent fluid; and composed of cells with large nuclei, free nuclei, elongated cells, &c., and was evidently cancerous. The liver, kidneys, and spleen, were healthy, so also the intestine. The ureters were not distended, the right one was spread out on the cyst, which occupied the usual position of the bladder; whilst the bladder was itself flaccid and situated on the left side of the hypogastric tumour. The peritoneum was smooth and healthy. The mucous membrane of the bladder, the prostate and urethra, the vesiculæ seminales, and vasa deferentia were all normal. To the right of the bladder, in the median line, and apparently developed in the loose cellular tissue of the bladder was a large hydatid cyst, holding nearly three pints of small cysts, varying in size from a line to an inch in diameter, and full of clear fluid. At the base of the cyst was firm yellowish gray substance, containing plates of cholesterine. The cysts beautifully showed their lineated structure, and numerous hooklets of the echinococcus were observed. The cyst had apparently commenced in the neighbourhood of the prostate.

Remarks.—The diagnosis of cancerous disease at the pylorus in this case was made out without difficulty; but there was much obscurity as to the character of the hypogastric cyst. There was no difficulty in micturition, and the patient was scarcely aware of the presence of the tumour; in some instances the ureters are compressed; this is shown in one of the instances recorded by Dr. Bright, the pelves of the kidneys became distended, and suppuration took place in them; in

that case some of the hydatids were discharged with the urine. Occasionally, the pressure is upon the urethra, when the cyst may still more easily be confounded with distended urinary bladder. Mr. Henry Thompson mentioned at the Pathological Society a case of this kind, in which the cyst was tapped per rectum, and the hydatid contents discharged, retention of urine being produced by the anterior pressure. These cysts appear to be generally developed in the cellular tissue at the base of the bladder, and do not produce any symptoms as long as the ducts are uncompressed, or other structures uninvolved. Cases not very unfrequently occur of hydatids being discharged with the urine, in which probably cysts of similar character to the one found in the case just detailed, have ulcerated through into the urinary passages; or they have located themselves in the kidney.

In the two following cases, the presence of the hydatid cysts were not suspected during life, and appeared to be coincidents of disease, rather than at all connected with the fatal issue; in the one, hydatid cyst in the liver was connected with cirrhosis, in the other with meningitis of the cerebro-spinal membranes and diphtheria.

CASE VII.—Hepatic ascites; hydatid in the liver.

Mary A—, æt. 59, was admitted under Dr. Barlow's care, on September 14th, and died on December 18th, 1859.

She was a stout single woman, a housekeeper, who ceased to menstruate ten years previously, and since that time her health had not been good. Her health failed in autumn, 1858, and in January, 1859, she consulted Dr. Barlow for jaundice; since that time she had had pain in the abdomen. In August, she felt the abdomen larger, and it had gradually increased in size. She was a large woman; on admission, the face was congested, the abdomen very much distended and tympanitic; at first, fluctuation was very imperfectly felt, but afterwards it became more distinct; the liver was enlarged, and at the lower part of the abdomen a hard mass was detected. There was slight dyspnœa, the pulse was compressible, the hands hot, the legs swollen. Effusion afterwards took place into the abdomen, and she slowly sank.

On inspection.—Advanced cirrhosis of the liver was found,

and a hydatid cyst, with dense walls, and pultaceous contents was present in the gland. It is probable that the hydatid cysts had very little to do with the hepatic symptoms and the fatal result.

CASE VIII.—*Hydatid disease of the liver; diphtheria; cerebral and spinal meningitis; pleurisy.*

Theresa P—, æt. 27, admitted into Guy's Hospital, July 7th, and died on the 8th, 1858. She had lived in Maze Pond, a married woman, who had nursed an infant for six months; her husband was out of employ, and she had worked at a laundry. She had always enjoyed good health, and felt well till June 30th, when she was seized with pain in the side. She did not complain of her throat till the day of admission, but did not appear seriously ill. She soon became much worse, swallowed with difficulty and ceased to speak, but appeared sensible; she moved her arms about; her face seemed somewhat distorted, and one pupil was larger than the other. She died the day after admission.

Inspection.—On removing the dura mater, the whole of the surface of the brain beneath the arachnoid was seen to be covered with lymph; the sulci filled with it; there were two or three drachms around the medulla and cerebellum. The ventricles contained double the normal quantity of fluid, of an opaque kind. The central parts of the brain were soft. The purulent lymph ran from the spinal cord, and the cord was found to be covered with it throughout its whole length. The bones were healthy. The pharynx, the posterior part of the tongue, and the upper part of the epiglottis were covered with a membranous exudation, but it did not extend into the larynx; the edges of the epiglottis were vascular. The exudation was composed of beautifully interlacing torula. The back and lower part of the left lung were covered with lymph, and there was some fluid in the pleura. The heart and intestines were healthy; so also the rest of the abdominal viscera, except that a hydatid cyst, about the size of the fist, was situated in the right lobe of the liver. It contained several smaller cysts. There was no suppuration in it, and it did not appear to have produced any symptom.

CASE IX.—*Pneumonia. Hydatid cyst, situated between the stomach and colon.*

Sarah F—, æt. 50, admitted under Dr. Lever's care, December 2d, 1858, and died on the 8th.

Inspection.—The body was slightly œdematous. There was grey hepatization of the right lung, and the pleura was covered with lymph. The pericardium was healthy. A large tumour could be felt in the abdomen, about the size of a foetal head. On opening the abdomen, the tumour was seen to be situated in the median line, between the stomach and colon, and covered by omentum. It was attached to the right lobe of the liver by a fibrous band. The cystiform tumour was round, its walls partially ossified; the contents of the cyst were degenerating; no echinococci were found. On the surface of the cyst was a smaller one, shrunken and contracted. The kidneys were granular.

It was probable that this cyst was originally connected with the liver; it did not interfere with the ordinary function of the abdominal viscera, nor was it the cause of death. It is interesting as being one of those cases in which the diagnosis is difficult; the colon was pushed down, and the cyst was situated in the sac of the lesser omentum. If it had attained a large size, it might easily have been mistaken for ovarian disease.

CASE X.—*Hydatid disease of the liver.*

Ellen D—, æt. 7, was admitted into Guy's Hospital, under Dr. Addison's care, October 24th, 1855. She had resided at Enfield, and her previous health had been good. Ten weeks before admission, the mother discovered a swelling in the abdomen; and it had probably existed for a longer period, as the child had been observed to protrude the abdomen, but there was no pain or inconvenience. Two other children of the same family had had worms, but not this little patient. She was a florid child, cheerful, and well nourished. There was a circumscribed swelling at the epigastric region, extending from

the ensiform cartilage to the umbilicus, a little to the right of the median line, six inches in length and five in breadth. The superficial veins were slightly enlarged. The tumour was dull, but no fluctuation could be felt; it was more prominent, and descended during inspiration, but there was no pain, nor disturbance of ordinary functions. It was determined not to employ any operative measures, and the child was sent home.

CASE XI.—*Hydatid disease of the liver.*

Cornelius D—, æt. 9, a poor Irish boy, residing in Snow's Fields, was admitted into Guy's Hospital, under my care, May 23d, 1860. Twelve days before admission he fell on the floor, striking his head and side; pain in the side came on, and swelling was then perceived. The mother stated that he had been pale for three months. The liver could be felt much enlarged, extending nearly to the crest of the ileum, and presenting a rounded projection near the false ribs; there was no pain nor fluctuation in the tumour; the appetite was good; the bowels regular; there was no evidence of disease of the thoracic viscera. The boy appeared to have been very badly fed; and with better fare, and a little cod-liver oil and iodide of iron he rapidly improved in health. No change whatever took place in the enlarged liver, and since he experienced no discomfort from it, he was discharged.

Cases x and xi occurred in young children. There appeared to be little doubt as to the character of the disease, but it was not thought prudent in either case to puncture the cyst; they did not interfere, apparently, with gastric or hepatic functions, and were marked instances of the insidious manner in which hydatid disease of the liver attains a considerable size, without causing any symptom; both appear to have been discovered accidentally. The presence of worms in other members of the family, in Case x, is an interesting fact in connexion with the etiology of the disease. As to the ages of these cases, we rarely find that hydatids occur in still earlier life; but in a case of a child only five years of age, a year or two ago, under Dr. Gull's care in Guy's Hospital, the presence of hydatid cysts in the liver was probable; the little patient left the hospital.

CASE XII.—*Hydatid disease of the liver.*

John H—, æt. 35, a single man, was admitted into Guy's Hospital, under Dr. Wilks' care, May 16th, 1860. As a sailor, he had been in both the East and West Indies; his habits of life had been exceedingly intemperate, but for the last sixteen years he had almost totally abstained from intoxicating liquors. With the exception of an attack of delirium tremens when he was nineteen years of age, he had generally enjoyed good health, till two years and a half ago, when he first felt pain in the posterior part of his right side, about the lower ribs; and he also noticed that his side was larger than it ought to be. The swelling increased, and extended round to the front. He applied for medical relief, and took salines with taraxacum, and blisters were applied to the side, with the effect, as he stated, of diminishing the tumour.

On admission into Guy's Hospital he was a short man, muscular, excitable, of anxious countenance, and sallow appearance; his tongue was moist and furred; the pulse 85, regular, and small; the thoracic viscera appeared to be normal, except that dulness extended on the right side, as high as the fourth rib. The abdomen contained a large tumour, extending from the ribs to an inch below the umbilicus, and also reaching into the left hypochondriac region; it was dull on percussion. His appetite was good, but he complained of much distension after a meal; the bowels were regular, the evacuations pale; the urine sp. gr. 1017, free from albumen. The patient stated that he had sometimes eaten raw salt pork. Iodide of potassium and infusion of gentian were given; and it was proposed to make an exploratory puncture into the cyst, but the patient left the hospital.

CASE XIII.—*Hydatids in the pericardium; adherent pericardium.*

An account of this case may be found in the Transactions of the Pathological Society, for 1855. A girl, æt. 16, was admitted into Guy's Hospital, on the 12th April, 1854, under Dr. Barlow's care, and died on the 28th. She had been affected with rheumatism a year before admission; and was

suffering from dyspnœa, and symptoms resembling obstructive valvular disease. A loud systolic bruit was heard. She was of short stature; puberty imperfectly developed. Considerable venous congestion of the head and neck was observed; there was œdema of the lower extremities, and in a less degree also of the upper. The pericardium was universally adherent; and at the anterior aspect of the heart, was a considerable prominence, about half an inch above the rest of the surface, and extending over a space of about two inches and a half by one inch. This contained about two ounces of very thick pus. The fluid was surrounded by a tolerably thick wall, and contained numerous cysts. Other minute cysts were observed on the inner wall; but no echinococci could be found. The cysts were composed of beautiful linear layers. The right auricle and ventricle were encroached upon by this cyst, which extended between the two cavities. The whole heart was enlarged, its cavities were distended with a pitchy clot. The mitral valve was contracted and thickened, and at its margin was a crop of minute vegetations; the endocardium, near the mitral, was opaque. The abdominal glands and mucous membranes were much congested, and the peritoneum contained serous effusion.

The valvular disease of the heart produced its ordinary symptoms; but the obstruction to the circulation, and the impediment to the free action of the heart, were doubtless increased by the cyst in the pericardium encroaching upon the ventricular cavities. The cysts were quite external to the heart, but Dr. Budd has recorded, in the *Pathological Transactions*, a very remarkable instance of a woman, æt. 23, who died from cardiac obstruction, with hydatids. The pericardium contained a hydatid tumour at the apex of the right ventricle; a small unattached hydatid was found beneath one of the laminae of the tricuspid; another, unbroken, was in the pulmonary artery, immediately above the valve, and before its sub-division several other smaller ones; other smaller clusters of cysts were found in the branches of the same pulmonary vessel. None were present elsewhere.

Instances of hydatid disease are very numerous; and the cysts are found in almost all parts of the body. Although frequently first detected on the post-mortem table, there are

many facts well ascertained in connection with their symptoms, course and termination, which are our guide to prognosis and treatment.

1. If the cysts attain a considerable size, and are near to the surface, we generally find a rounded tumour, dull on percussion, having peculiar elasticity; and, unless from position, exerting pressure on important structures, or from their very large size, they do not produce any distressing symptoms, or interfere in a marked degree with health. The cysts sometimes remain for a great number of years without much enlargement or symptom; a case has been published where a tumour, afterwards proved to be hydatid, existed for twenty years.

2. The hydatids often lose their vitality and cease to increase; degenerative changes take place in the cyst and in its contents; the former becomes thickened, and often has plates of cholesterine, or ossific particles in it; the latter may be converted into pus, or become a pultaceous mass.

3. Spontaneous rupture and recovery sometimes occur; either directly through the skin or into adjoining viscera; as through the bronchial tubes, the intestines, the bile ducts, the bladder, &c.

4. The causes of death are various:

From pressure on adjoining structures, as in Case III.

From rupture into the pleura, as in Case I.

From rupture into the lungs and bronchi.

From rupture into the peritoneum. Case IV.

From rupture into the intestine.

From rupture into the bile ducts.

From suppuration of the cyst and pyæmia.

From secondary suppuration, external to the cyst, consequent on its pressure.

From hæmorrhage, as in a case mentioned by Dr. Bright, in which a cyst had opened near the umbilicus, and bleeding took place into the cyst. And a remarkable case recorded in the Pathological Transactions, by Dr. Hillier, in which a cyst extended into the bile ducts, and also into a large hepatic vessel, causing fatal effusion of blood into the stomach and intestines.

From impeded circulation, as where the cyst is connected with the pericardium, and still more so, where the cysts are in the current of the blood itself.

6. Internal remedies do not appear to be productive of very marked beneficial results; although diminution of the size of the cyst has followed the use of iodide of potassium, &c. External remedies, as iodine, blisters, and electricity, are equally unsatisfactory.

7. Operative measures have been followed by success, but often have imperilled and destroyed the life of the patient.

8. The mode of operation has been various :

By removing the entire cyst, as from the extremities.

By drawing off the contents of the cyst directly, but guarding against extravasation into the abdominal cavity by firm pressure, by strips of plaster and bandages, as adopted by Mr. Hilton in the case under Dr. Rees' care, recorded in the Reports of 1848.

By removing smaller quantities of the fluid repeatedly, so as to diminish the tension of the cyst, but with less liability to the admission of air, as in Mr. Cock's case.

By using an exhausting syringe to withdraw the fluid through a trochar, as recommended by Dr. Budd (according to the plan of Dr. Bowditch, of Boston, in the treatment of empyema), thus destroying the pressure on the hydatids, and leading to their death and absorption. If necessary, the whole contents of the cyst may be removed in a similar manner :

By ensuring peritoneal adhesions by the use of potassa fusa, applied to the most prominent part of the tumour.

By the injection of iodine, as described by M. Leudet, after the method of M. Recamier: 1st, applying caustic potash nearly to perforation, then drawing off the contents of the cyst, and washing it out, and introducing a weak solution of iodine. Various other substances have been used as injections, barley-water, solution of chloride of lime, or of chloride of sodium, &c.

Although the latter plan has been attended with considerable success, the instances of tapping which have been followed by least

constitutional disturbance, and the most satisfactory result have been those in which suppuration has not taken place. As far as we have observed, the method of drawing off small quantities without the admission of air appears most deserving of trial. A measure so fraught with danger, cannot be resorted to without great deliberation; but the improbability of a large hydatid cyst becoming absorbed, and the dangers attending its evacuation through natural channels, would lead us, where the diagnosis is clear, to recommend the plan of cautiously removing a portion of the contents of the cyst, and, if necessary, repeating the operation several times.

CASE 1. James S., æt. 31, hydatid in the liver; rupture into the pleura; death.

„ II. Henry B., æt. 36, hydatid in the liver; contents evacuated by repeated operations; recovery.

„ III. Elizabeth L., æt. 31, hydatid in the liver; pressure on the vena cava; death.

„ IV. Hiram B., æt. 50, hydatid in the liver; cyst extending into the common bile duct; suppuration; jaundice; peritonitis; death.

„ V. William M., æt. 29, hydatid disease of the liver, supposed to open into the duodenum; convalescence; subsequent death.

„ VI. William A., æt. 52, death from cancer of the pylorus; hydatid in the cellular tissue of the bladder.

„ VII. Mary A. A., æt. 59, hepatic ascites; hydatid in the liver.

„ VIII. Theresa P., æt. 27, diphtheria; cerebro-spinal meningitis; hydatid in the liver.

„ IX. Sarah F., æt. 59, pneumonia; hydatid cyst situated between the stomach and colon.

„ X. Ellen D., æt. 7, hydatid in the liver.

„ XI. Cornelius D., æt. 9, ditto.

„ XII. John H., æt. 35, ditto.

„ XIII. Girl, æt. 16, valvular disease of the heart; hydatid in the pericardium.

FACTS AND FALLACIES

CONNECTED WITH THE

RESEARCH FOR ARSENIC AND ANTIMONY;

WITH SUGGESTIONS FOR

A METHOD OF SEPARATING THESE POISONS
FROM ORGANIC MATTER.

BY ALFRED S. TAYLOR, M.D., F.R.S.

THE processes which have been hitherto successfully employed by toxicologists for the detection of arsenic in the tissues are those of Marsh and Reinsch. Although the principles on which they are based are doubtless well known to the readers of these 'Reports,' it is necessary to make a few observations upon them before proceeding to describe that method which, while it appears to me to combine the advantages of the two, is attended with less risk of fallacy than either process taken separately.

MARSH'S PROCESS.

Marsh's process consists in the conversion of the ordinary compounds of arsenic to arseniuretted hydrogen gas, in a properly constructed apparatus. In an early volume of these 'Reports' (vol. ii, p. 76, 1837), I published an account of Mr. Marsh's discovery, with a drawing of the apparatus used and recommended by him. Mr. Marsh confined his results to the combustion of the gas, the appearance of the metallic deposits, and the production of arsenious acid as one of the results of

¹ Vol. ii, p. 76, 1837.

combustion. Since that date numerous forms of apparatus have been suggested; and the means of distinguishing arsenical from other deposits resembling them, have been described in most works on chemistry and toxicology.

It is conceded by all those who have experimented on the subject that, in the absence of disturbing causes, this is a most delicate process for the detection of arsenic. Mr. Marsh himself does not claim for it a higher degree of sensitiveness than that of enabling him to detect the 1-120th part of a grain of arsenic (the quantity contained in one minim of Fowler's solution); while, with regard to the effect of dilution, he found that one grain of arsenic in twenty-eight thousand grains (or four imperial pints) of water, furnished, when placed in a larger apparatus constructed for the purpose, upwards of one hundred distinct metallic arsenical crusts.¹ MM. Danger and Flandin assert that metallic deposits may be procured when the arsenic forms only 1-200,000th part of the liquid examined (*De l'Arsenic*, p. 83); while M. Signoret states that he has procured metallic deposits with only the 1-200,000,000th part of arsenic in the liquid. This is equivalent to one grain of arsenic dissolved in three thousand gallons of water. We must regard these results either as greatly exaggerated, or depending upon some peculiar mode of computation. In general, either the degree of dilution with water or the supposed weight of the deposit derived from combustion, has been taken as the standard of delicacy; but the real question in practice is, what weight of arsenic can be detected in the minimum quantity of liquid required for use in Marsh's tube. From experiment I find, that deposits may be obtained from the 2000th part of a grain, and that they assume a reliable character, and admit of the application of corroborative tests when the weight of arsenic reaches the 1-100th of a grain. By a mode of operating different from that advised by Mr. Marsh, it is possible to extract and procure, in a visible metallic deposit, the whole of the metallic arsenic contained in the 2000th, and even in the 4000th part of a grain of arsenious acid; but to these small quantities it is difficult, if not impossible, to apply the requisite number of corroborative tests.

¹ On the Separation of Arsenic, 'Transactions of the Society of Arts,' vol. li, p. 10.

Mr. Marsh intended that his method of detecting arsenic should be substituted for the ordinary process of reduction and the use of the liquid and gaseous tests; but its claims to consideration rested upon an entirely different ground, namely, the power which it conferred on chemists, for the first time, of detecting the poison in the soft organs and fluids of the body. Up to the date of this discovery there were no chemical proofs that arsenic was absorbed or deposited in the tissues of the living body. In reference to the application of the process to organic substances, Mr. Marsh advised that, if the suspected substance was a solid, it should be boiled with two or three ounces of water, and the liquid filtered and introduced into the tube. If it was liquid, such as thick soup, the contents of the stomach, gruel, tea, cocoa, &c., he simply recommended that it should be thrown on a filter to separate the more solid parts, and that the liquid portion should be placed in the tube or inverted bottle in which the hydrogen was generated (p. 4). Thus, then, he brought every substance to the liquid state, while he made no attempt to separate the organic matter; or, when the poison was in small quantity, to reduce the bulk of the liquid by previous concentration. On the contrary, his plan simply consisted in enlarging his apparatus for large quantities of liquids (p. 9). In one experiment, he operated on half a gallon of water containing one grain of arsenic; and in another he states that he obtained equally satisfactory results from operating at once on *three pints* of very thick soup, the same quantity of port wine, porter, gruel, tea, &c. (p. 10). In these analyses of large quantities of liquids, the process of evolving the gas was allowed to proceed very slowly, and several days elapsed before the mixture ceased to give indications of the presence of arsenic. In order to prevent the effect of the frothing arising from the generation of hydrogen in an organic liquid, Mr. Marsh recommended the greasing or oiling of the shorter limb of the apparatus, before introducing the substance to be examined (p. 7). Having been a member of the committee that awarded to the late Mr. Marsh, in the year 1836, the large Gold Medal of the Society of Arts, for his ingenious discovery, and having seen him operate, I can confirm the correctness of the above extracts from his paper. Although, as he left it, his invention was a useful addition to

the ordinary processes for detecting arsenic in clear liquids, it was quite unfitted for the detection of the poison when associated with much organic matter..

The first improvement on Marsh's method of analysis was made by Orfila, in 1839. This toxicologist deflagrated the organic matter in a dry state with nitrate of potash, according to a plan suggested by Rapp. He subsequently employed nitric acid, to destroy the organic matter; he then brought the mass, by evaporation, to a dry, carbonaceous state, and acted on the residue by nitro-hydrochloric acid. The arsenic was dissolved in water as arsenic acid, and in this state it was placed in the hydrogen apparatus. By means of these processes, Orfila was enabled to concentrate the arsenic, to remove it from the organic matter; and thus, by the aid of Marsh's tube, he succeeded in detecting the poison in nearly all the organs and fluids of the body. MM. Danger and Flandin advised the carbonization of the organic matter by concentrated sulphuric acid and heat. Fresenius and Babo destroyed the organic matter by boiling the substance in a mixture of hydrochloric acid and chlorate of potash; and others, with a similar object, have employed chlorine and potash. In all these cases, the arsenic is more or less completely converted to arsenic acid, and in this state the presence of the poison is easily demonstrated. Analysts who have had occasion to employ these various methods of destroying organic matter, must have observed that, in some instances, they are liable to occasion a loss of arsenic; in others, they overload the liquid with chemical compounds, or in default of entire carbonization, they yield a dark, syrupy residue, which is liable to produce so much froth in the tube, as to render it difficult to procure arseniuretted hydrogen gas in a state fitted for testing. The use of nitric acid in large proportion, as advised by Orfila, is objectionable; for unless great care is subsequently taken to expel the whole of this acid, the arsenic is not in a proper state for separation, either by the process of Marsh or by that of Reinsch.

Apart from the great trouble and difficulty of procuring the organic liquid in a state fitted for evolving arseniuretted hydrogen, there are other obstacles to the reproduction of the gaseous compound in the presence of certain metallic and non-metallic

substances. The presence of copper or mercury in a liquid, or of chlorate of potash, either interferes with the free production of arseniuretted hydrogen, or leads to its decomposition when produced. In addition to the fallacies pointed out by others, I may mention that in the course of the analyses made in Smethurst's case, I found that 1-96th of a grain of arseniate of potash mixed with a small quantity of solution of chlorate in the tube, did not give the slightest indication of the presence of arsenic. It was only when the proportion added was about 1-16th of a grain, that deposits were readily procured by the combustion of the gas. An exclusive reliance upon Marsh's process, when applied in the manner recommended by the discoverer, might, therefore, lead an analyst to the erroneous opinion that arsenic was absent, when the presence of the poison might be safely demonstrated by other methods of research.

Deposits or stains resembling those of arsenic, and liable to be mistaken for them, may also be met with under circumstances of which the conditions are but little understood. It was by some accidental result of this kind that Orfila was led to affirm that arsenic was a constituent of all flesh, and of animal matter generally. This statement was, however, subsequently proved to be unfounded, before a committee of the Institute. The cause of the fallacy which had misled so great an authority was not however satisfactorily explained. Antimony, phosphorus, selenium, sulphur, &c., and even iron and zinc may, it is well known, so combine occasionally with hydrogen, as to deceive analysts, who rely upon the appearance of the deposits.

The process of Marsh may be employed either with or without the combustion of the arseniuretted hydrogen gas, and the examination of the products of its decomposition. Assuming that the gas is burnt in the manner recommended by the discoverer; namely, as it issues from a small jet,—I believe that the best method at present known for determining the arsenical nature of the deposits, is the following: The deposits should be collected in small porcelain capsules. 1. Add strong *Nitric acid*, which dissolves the deposit, and evaporate the acid liquid on a sand-bath to dryness. A white deliquescent residue remains, which gives a reddish-coloured

precipitate, with a solution of nitrate, or of ammonio-nitrate of silver (arsenate of silver). 2. A strong and fresh solution of *Chloride of lime* immediately dissolves the arsenical deposit, and on evaporating the liquid to dryness, white arsenate of lime remains, which gives the red precipitate above mentioned, when nitrate of silver is added to it. 3. *Sulphide of ammonium* does not readily dissolve the deposit, but when mixed with it, enough is dissolved to leave, on evaporation, yellow sulphide of arsenic (orpiment), soluble in ammonia, but insoluble in cold hydrochloric acid. The pale, steel-blue colour of the flame, with the production of a white smoke (arsenious acid), and the metallic deposits or mirrors, received on glass or porcelain, are well-known characters of arseniuretted hydrogen gas in a state of combustion.

It has been suggested that the copper or silver tests might be applied to the products by moistening surfaces of glass with the respective solutions, and holding them at a short distance above the flame, so that the arsenious acid evolved during combustion might be received upon them.

It is well known that *Antimony* combines with hydrogen, and that this gas, when burnt, produces deposits resembling those of arsenic. These may be collected in porcelain capsules, and tested by the method above described. 1. Strong *Nitric acid* dissolves the deposit. On evaporation to dryness, a white, insoluble compound is left (an insoluble oxide of antimony). Nitrate of silver added to this white residue produces no change, unless there was arsenic combined with the antimony, in which case a spot of red arsenate of silver will appear. If to the colourless mixture of oxide of antimony and nitrate of silver, a small quantity of ammonia be added, or the stopper of a bottle containing ammonia be brought near, the residue in the capsule is immediately blackened, owing to the production of an insoluble compound of antimony and silver. 2. A strong solution of *Chloride of lime* does not readily dissolve the antimonial deposit. Even when heated on a sand-bath, there is no change, and the dry residue gives no red precipitate when mixed with nitrate of silver. 3. *Sulphide of ammonium* dissolves the antimonial deposit; and on evaporation, a white residue of antimony remains in the capsule, insoluble in ammonia, but easily dissolved by cold hydrochloric acid.

Antimonial deposits are thus easily known from those of arsenic.

The flame of antimoniuiretted hydrogen is of a pale, yellowish-white colour. It furnishes black or smoky-looking deposits on glass or porcelain, which are remarkably different from the metallic-looking, and brown-coloured deposits of arsenic. The white oxide of antimony, evolved by combustion, does not produce in the liquid tests for arsenic, held above the flame and within the vapour, any coloured precipitates. The ammonio-nitrate of silver is simply blackened as a result of the reduction of the metal.

Arsenic and antimony are thus very easily identified when Marsh's original process of burning the gas is resorted to. Many other distinctions have been suggested; but it is not necessary to specify these, as the above characters serve to distinguish the two metals clearly from each other, and both of them from all other metals known to chemists. The original process of Marsh is by no means so well adapted for the detection of antimony as of arsenic. The antimony, when introduced into the tube in a state of acid solution, if in small quantities, is liable to be rapidly precipitated on the zinc in the form of a black powder, and the current of gas soon ceases. When the 1-100th of a grain of tartar emetic was dissolved and placed in the tube with pure water and hydrochloric acid, there was not the slightest indication of the presence of antimony. It was only when the quantity amounted to about a grain, that a number of well-marked deposits, in a state fitted for testing, could be procured by the combustion of the gas. In employing this process, we may meet with deposits so small and ambiguous from their thinness, that the corroborative tests may fail to show their nature. In this case, it will be advisable not to rely upon the combustion of the gas, but upon its decomposition by heat, and the reagents to be hereafter described.

As a result of this examination of the process of Marsh, it may be stated that there are two difficulties which the analyst encounters in resorting to it for the separation of arsenic from the solids or fluids of the body. First, there is no good or simple method of bringing the arsenic to a concentrated state, *i.e.*, to a state fitted for testing without producing

froth; and secondly, when the quantity of arsenic in an organic liquid is so small as to render the adoption of the process necessary, it is not possible to follow the plan of the inventor, of generating the hydrogen in the whole quantity of the organic liquid.

The chemical facts upon which this process is based, had been long known to scientific men, but it is not the less creditable to Mr. Marsh, that he should have been the first to make a practical application of them for the detection of arsenic. Arseniuretted hydrogen was discovered by the Swedish chemist, Scheele, about the year 1775. He proved that it was a combustible gas, and that one of the results of its combustion was a regulus of (metallic) arsenic. Proust, in 1806, Trommsdorf, in 1803, and Stromeyer, in 1806, successively examined the gas, and described methods for its production. Stromeyer found that it burnt with a blueish white flame, and that the products of its combustion were a mixture of arsenious acid and metallic arsenic (brown oxide of arsenic). Further, that it was decomposed by nitric and nitrous acids, by aqua regia, by chlorine, and a great number of metallic solutions, the products being water, arsenious and arsenic acids. In 1815, the gas was examined by Gehlen, and he discovered a new method of preparing it, by applying heat to a mixture of arsenic and caustic alkali. Its highly poisonous nature was demonstrated by the death of Gehlen from the respiration of a small quantity of the gas, during the performance of his experiments. An incautious manipulation with this gas has since led to fatal consequences in at least three cases. Every cubic inch contains one-fourth of a cubic inch of arsenic in vapour, and an atmosphere containing one-tenth by volume of the gas, is fatal to animal life (Berzelius). The gas contains by weight more than 96 per cent, of arsenic. It is very heavy, its specific gravity being 2.69. In 1830, Soubéiran published his researches on this compound. This chemist confirmed the results of Gehlen on the production of the gas by heating a concentrated alkaline solution with arsenic; and he also made the two important discoveries: 1st, that when a current of the gas was moderately heated in a tube by a spirit lamp, it was decom-

posed; and that arsenic of a bright metallic lustre was deposited on the interior of the tube; and 2dly, that a solution of a salt of silver was decomposed by it, and that water and arsenious acid were the products of the decomposition.¹

To Mr. Marsh alone is the credit due of applying some of these facts to a useful and practical purpose in toxicology, and the large number of processes which have been put forward since his time by various chemists as new inventions are nothing more than the adaptation of some of the above properties of the gas to Marsh's original process. The production of arseniuretted hydrogen from the action of an alkali on arsenic has been, in recent times, assigned to Fleitmann,—the decomposition of the gas by a solution of the nitrate of silver has been claimed by Lassaigne,—the method of decomposing it by heat has been described as the process of Berzelius, Liebig, or Chevallier, while the fixation and decomposition of it by nitric acid has been claimed by M. Meillet. It is, however, evident, from the remarks already made, that the whole of these properties of the gas were well known at the time of Marsh's discovery; and if the author himself did not make use of them, it was probably because he thought that those which he had selected, would suffice in all cases for demonstrating the presence of the poison.

The frequent occurrence of arsenic as an impurity in sulphuric acid and zinc created for some years a degree of distrust in the results obtained by the application of Marsh's process. Some toxicologists employed hydrochloric acid in place of the sulphuric, but this is liable to contamination with arsenic as a result of the distillation of salt with arsenical sulphuric acid. A large quantity of impure sulphuric acid is annually manufactured in this country, chiefly for agricultural purposes. From the researches of Dr. Davy it would appear that arsenic is thus conveyed into manures; and crops grown from the manured soil are found to be more or less impregnated with the poison.² He found the proportion of arsenious acid contained in the commercial sulphuric acid to be one grain to an ounce. Dr.

¹ Payen, '*Traité des Réactifs*,' 1841, Supplement, p. 5; Berzelius, '*Traité de Chimie*,' 1829, tom. ii, p. 433; and '*Manuel Pratique de l'Appareil de Marsh*,' par Chevallier et Barse, 1843, p. 60.

² '*Philosophical Magazine*,' August, 1859, p. 108.

Rees found the proportion to be 13·5 grains in twelve fluid ounces, and Mr. Watson found 21·3 grains in the same quantity of acid. Zinc not unfrequently contains both arsenic and antimony, and Dr. Clark, of Aberdeen, informed me some years since that he had scarcely found a sample of zinc free from traces of arsenic. Within a recent period more care has been given to the purification of these substances, so that the acid and metal may now be obtained without difficulty in a state fitted for use in Marsh's process. It need hardly be observed, however, that they should not be employed in any investigation until they have been submitted to a preliminary testing in quantities equal to those which are to be employed in the process.

REINSCH'S PROCESS.

Hugo Reinsch first announced his discovery in 1841.¹ He accidentally observed that a piece of copper which he had immersed in commercial hydrochloric acid acquired, after a time, a dark-gray metallic deposit, resembling iron. This proved, on examination, to be a deposit of metallic arsenic derived from an impure sample of hydrochloric acid. The acid was found to contain one grain of arsenious acid in 500 grains. This deposition of arsenic was observed to take place on copper whether the acid was hot or cold, and whether it was concentrated or diluted, but in all cases heat was found to accelerate it considerably. Reinsch further ascertained that copper might be boiled in a solution of arsenious acid, or in pure hydrochloric acid, without any similar deposit being formed. Provided there is not too free an access of air, and the metallic copper is wholly immersed in the acid, the metal will remain unchanged for a much longer period in the concentrated than in the diluted acid. If there is a free exposure to air, the metal is rapidly dissolved (as subchloride) by the concentrated acid, but not by the diluted acid.

The proportion of acid to water which was found most

¹ Erdmann's 'Journal für Praktische Chemie,' No. 19, 1841. 'Philosophical Magazine,' No. 126, Dec., 1841. 'Annales d'Hygiène et de Médecine Légale,' 1843, t. i, p. 439. See also a paper by the writer in the 'British and Foreign Medical Review' for July, 1843, p. 281.

convenient for the deposition of arsenic is not stated by Reinsch. One part of acid by measure to six, eight, or ten of water, have been the proportions generally adopted by analysts. From his experiments Reinsch drew the conclusion that the arsenic was so completely removed by copper on boiling it in the acid, that the residuary liquid gave no trace of the poison on the subsequent use of Marsh's apparatus. There were other and manifest conveniences attending the use of this method. The arsenic not being converted to a gas and burnt, there was no loss of the poison; it was entirely removed from the fluid in a state of pure metal, and the separation of it might be suspended and resumed at any subsequent period. Reinsch thought that his process was beyond the reach of any fallacy, because, when arsenic was really present in a liquid, even in small quantity, the deposit commenced in a few minutes, and was completed in half an hour; and during this time, if arsenic was not present, the copper would be still bright on its surface, and present no appearance which could give rise to any error.¹ The facts upon which the discoverer relied for the demonstration of the presence of arsenic were—1, the gray, metallic appearance of the deposit; 2, the conversion of this deposit by a moderate heat to a crystalline sublimate of arsenious acid, in which the octahedral form of the crystals would be recognisable; 3, the solubility of these crystals in water, and the results of the application of the liquid reagents for arsenic to the solution. The only important addition which has been since made to these corroborative tests consists in the conversion of a sublimate of the crystals to arsenious acid by nitric acid, and the production of red arseniate of silver on the addition of a solution of nitrate of silver to the dry residue.

With the above-mentioned results, Reinsch pronounced his process to be entirely free from any fallacy, or from any possibility of error. He also thought that there could be no loss of arsenic. He asserted that it was the most delicate of all the processes hitherto contrived for the detection of this poison, and that it would reveal its presence even when it formed

¹ 'Annales d'Hygiène,' 1843, i, 449. This view is not strictly correct; small quantities of arsenic or antimony contained in large quantities of organic matter require some hours' boiling for their entire separation and deposition.

only the 1-200,000th part of the solution. This remark obviously applies to the mere effects of dilution. The actual weight of arsenic which can be detected in a minimum quantity of water is not assigned by Reinsch.

Most analysts who have had occasion to employ this process can corroborate the statement of the discoverer, to the effect that it is simple, delicate, and easy of application. In regard to its delicacy—if the deposition of a metallic film on copper is taken as a criterion, I can state, from direct experiment, that the 1-4000th part of a grain of arsenious acid admits of detection. This small quantity of arsenic, dissolved in a minim of water and mixed with ten minims of water and two of hydrochloric acid, gave a thin, but well-marked, steel-blue coating to the twelfth part of a square inch of bright copper-foil. On the introduction of a second piece of the same size, there was scarcely any perceptible deposit. The arsenic in this experiment, formed only the 1-96,000th part of the weight of the liquid in which it was dissolved. When, however, the quantity of water was increased threefold, there was no deposit on the copper, even after boiling for a few minutes. By a still longer boiling, and a concentration of the liquid, the arsenic would no doubt have revealed itself.

It is proper to remark, in this place, that the delicacy of the process is affected, not only by the quantity of liquid in which the arsenic is diffused, but by the surface of metallic copper employed in the experiment. For the detection of minute quantities, the polished copper-foil employed should not exceed the eighth of an inch square, and the arsenic should be diffused through a minimum of liquid. By thus diminishing the amount of metallic surface to be coated, it is easy to demonstrate that a quantity of arsenic may be detected by Reinsch's process which Marsh's process would entirely fail to reveal, even under its most improved modifications.

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even in the bones, although he relates no experiment in support of this opinion.

At the date of publication of his process, it does not appear that Reinsch had practically applied it to the detection of arsenic in the fluids or solids of a dead body. He had no idea, apparently, of its important application to the separation of arsenic from the tissues. The only fact which I have found recorded on this subject is that he made a mixture composed of potatoes, soup, milk, &c., and introduced into it half a grain of arsenic. He boiled the whole with pure hydrochloric acid, diluted with its weight of water, filtered the liquid, and treated the filtrate with metallic copper. He found that the arsenical deposit was as easily obtained on the copper, in this experiment, as if acidulated water only had been used.

In the prosecution of his researches on arsenic, Reinsch found that *Antimony* formed an obstacle to the application of his process, as it did to that of Marsh. Tin and lead were not deposited under the circumstances; bismuth, mercury, and silver were deposited on copper, but in such a form as to create no difficulty to the analyst. The only serious objection was found to exist in antimony. This metal was precipitated on copper under precisely similar circumstances to arsenic. The colour was iron-gray or, when the antimony was in very small proportion, of a peculiar reddish or violet tint. Reinsch placed great reliance upon this colour as evidence of the presence of antimony. It is always procurable by sufficiently diluting the antimonial liquid, or by reducing, if necessary, the proportion of antimony present. To distinguish by some positive characters the antimonial deposit on copper when it had acquired the iron-gray lustre of arsenic, was a problem left unsolved by Reinsch. He merely states that, if the copper, having on it the antimonial deposit, be heated, a white, amorphous film of oxide of antimony is sublimed in place of the well-marked crystalline sublimate yielded by the arsenical deposit on copper under similar circumstances. His process, therefore, in reference to antimony, was very imperfect. It served only to reveal the presence of arsenic, either when existing alone or when combined with antimony and deposited with it on copper. I have found, in operating on mixtures of small quantities of arsenic and antimony—when the acid

liquid has been brought to the boiling point, and polished copper is plunged into it—that the antimony is first deposited in a violet film, which rapidly loses its colour by increasing in thickness, and by becoming coated with a layer of metallic arsenic. When heat is applied to the copper having on it a deposit of antimony or arsenic, or a mixture of the two, it will be found that arsenic is more easily volatilized. A heat of about 380° to 400° is sufficient to produce a crystalline sublimate of arsenic, and at this temperature antimony remains fixed; hence, in addition to the colour of the film, its fixedness at a moderate heat becomes an additional criterion of its antimonial nature.

One of the most simple and satisfactory methods of distinguishing the deposit of antimony on copper from that of arsenic, is to boil the copper in a weak solution of potash, containing no lead as impurity. This method was suggested by Mr. Watson, of Bolton, and was first employed by him in medico-legal analysis. By agitating the copper in the alkaline liquid, and occasionally exposing it to air in the tube in which the experiment is performed, the metallic antimony is rapidly oxidized and converted to a soluble antimonite of potash. The alkaline liquid is poured off, or, if necessary, filtered,—acidulated with hydrochloric acid, and a current of washed sulphuretted hydrogen gas is then passed into it. An orange- or reddish-coloured sulphide of antimony is precipitated. This may be collected on a filter and washed with strong ammonia, in which it is insoluble. As sulphide of arsenic is quite soluble in ammonia, the insolubility of the precipitate in this menstruum is a proof of its antimonial character. Any sulphide of arsenic contained in the precipitate would of course be removed by ammonia at this stage of the process. If, as it frequently happens, the solution of potash contains lead, sulphuretted hydrogen should be passed at once into the alkaline

the liquid filtered. Sulphide of lead is thus
sulphide of antimony may now be obtained from
trate by acidulating it with hydrochloric acid.

cases of antimonial poisoning at Liverpool, Dr.
wards, and myself, carried the demonstration a
The sulphide of antimony, collected on the filter,
trong and pure hydrochloric acid, and after the

odour of sulphuretted hydrogen had disappeared, the acid liquid was introduced with pure zinc into a small Marsh's tube, constructed for the purpose, and the dried gas submitted to a red heat in a capillary glass tube. A well-marked metallic deposit, having the characters of antimony, was thus obtained. A certain quantity of precipitated sulphide is required for obtaining this additional corroboration.

If a sufficient quantity of oxide can be procured as a sublimate by heating one or more pieces of copper coated with antimony, this oxide may be dissolved in a small quantity of a strong solution of pure tartaric acid; and this solution, on being treated with a current of washed sulphuretted hydrogen gas, gives a precipitate of orange-red sulphide of antimony. This method was successfully adopted by Dr. Edwards in some of his numerous analyses in the Liverpool cases of antimonial poisoning (1860).

In these 'Reports' for October, 1856, Dr. Odling published a method of testing the antimonial deposit on copper by boiling the metal with a weak solution of permanganate of potash and potash. The antimony is here oxidized at the expense of the oxygen of the permanganate; by Mr. Watson's method it is simply oxidized by exposure to air. Of the two, the latter is less open to objection.

A method which I had previously adopted consisted in deflagrating the copper with the antimonial deposit in a mixture of nitrate and carbonate of soda. Antimoniate of soda was thus formed. This, when dissolved in water and acidulated with hydrochloric or tartaric acid, yielded, under a current of sulphuretted hydrogen gas, a deposit of sulphide of antimony, the colour of which, however, was liable to be obscured by an admixture with some sulphur. This mode of corroboration is not so delicate as that proposed by Mr. Watson.

The process of Reinsch, therefore, is now rendered as satisfactory for the detection of antimony as of arsenic; and by comparison with the process of Marsh, it is not only more delicate, but far more convenient in its application. Marsh's process may be used in the manner above described simply for corroboration.

In comparing the two processes for the separation of anti-

mony from liquids, I have found that Reinsch's method is twenty times more delicate in revealing the presence of antimony than that of Marsh, as it is usually employed.

Thus, a minim of water containing the 1-2000th part of a grain of tartarized antimony, mixed with ten minims of water and two of hydrochloric acid, gave a violet-coloured deposit of metallic antimony on boiling in it a piece of pure copper-foil corresponding to one twelfth of a square inch. A second piece of equal size introduced came out of the liquid untarnished; hence all the antimony had been deposited. Estimated by the degree of dilution, the proportion of antimony here separated was not more than the 1-48,000th part of the liquid. These appear to be the limits of Reinsch's process for antimony; and it will be seen that it is twice as delicate for arsenic, since the 1-4000th part of a grain of the latter metal admits of separation as a visible deposit.

The introduction of Reinsch's method gave great facility to the detection of arsenic in the *tissues*. The organ or solid containing arsenic was cut up and boiled in the requisite proportions of water and acid; it yielded a liquid which readily gave a deposit of metallic arsenic on copper. In some cases the acid liquid was strained or filtered off and tested; in others, the copper was at once boiled with the organ cut into small pieces. In either case the long and troublesome carbonization of the viscera was dispensed with; and the frothing in Marsh's process, as well as the ambiguous stains from a variety of substances, were no longer obstacles to the analyst. This method has been very extensively employed in this country in judicial researches. It has been used by Dr. Christison, Dr. Douglas Maclagan, Dr. Geoghegan, Mr. Watson, Mr. Herapath, and other analysts of repute for many years; and the result of their united experience appears to be, that it is admirably adapted for the detection and separation of arsenic from the tissues of the body.

The first record of its employment in this country for the detection of absorbed arsenic in the tissues, for medico-legal evidence, was in the case of Mrs. Gilmour, who was tried in Edinburgh, in January, 1844, on the charge of murdering her husband by poison. Dr. Christison found arsenic in comparatively large quantity in the liver, by boiling a portion of

this organ with diluted muriatic acid and copper. This was the second instance in which, up to that date, the poison had been found in the liver in this country. In conjunction with Dr. Penny, of Glasgow, he has used this process up to a recent date, namely, in the case of Madeline Smith, who was tried at Edinburgh on a charge of poisoning, in June, 1857.¹ In the last edition of his 'Poisons,' p. 271, Dr. Christison says of the discovery of Reinsch, that "it forms the groundwork of the best process of all yet proposed for the detection of arsenic in solution." In short, those who have tried the two processes have in the end generally preferred that of Reinsch. Mr. Herapath, of Bristol, who has had great experience in the examination of cases of arsenical poisoning, states that he prefers, and has always acted upon, the principle first proposed by Reinsch.² With this strong testimony in its favour, it cannot be a matter of surprise that Reinsch's process has been and continues to be so much employed by English analysts for the detection of arsenic in the dead body.

There is this difference between the two discoverers, Marsh and Reinsch—while the former suggested a useful application of facts already made known by others, the latter discovered for himself the simple fact upon which his process is based. Until within a recent period it was thought, too, that the materials used in the process of Reinsch were far less liable to give rise to fallacious results than the materials required for the process of Marsh. The investigations, however, which were carried out by Dr. Odling and myself in the case of Isabella Banks (the case of 'The Queen against Smethurst,' August, 1859), showed that there was a latent fallacy connected with the use of Reinsch's process, of the existence of which neither Reinsch nor any toxicologist of repute had had, up to that date, the slightest suspicion. This was the discovery of arsenic in all the best and so-called purest varieties of copper, whether as foil, gauze, or wire, and in sufficient proportion to give rise, under certain conditions, to fallacious results.

¹ 'Report of Trial by Irvine,' 1857, p. 61.

² Ure's 'Dictionary of Arts and Manufactures,' Part i, November, 1859, p. 191.

ARSENIC AS AN IMPURITY IN COPPER.

It has been hitherto considered that one of the great advantages of Reinsch's process was that, while hydrochloric acid might easily be obtained pure, no question could arise about the impurity of copper. The presence of arsenic in the purer forms of this metal was, until 1859, either not suspected or wholly ignored by chemists of the highest authority. It now turns out that there is no kind of copper available for use which is free from arsenic; and some kinds of foil and wire hitherto used, and still employed by analysts of repute, contain arsenic united to copper as arsenide in comparatively large proportion. As this question is of considerable importance, not only in reference to the present, but the future employment of this useful process in judicial investigations: and, from causes which I need not here enter into, it has not hitherto received that calm attention which it merits, I shall endeavour to lay before the reader the facts which I have ascertained regarding the presence and influence of this impurity in a medico legal analysis.

In turning to Reinsch's original report of his discovery, it will be found that, while he enforces attention to the purity of the *acid* employed, he merely directs that the *copper* should, previously to use, be cleaned with nitric acid, washed in water, and rubbed dry with filtering-paper. These are all the precautions given by the discoverer in reference to the selection of the copper. In fact, upon his plan, any copper might be used, provided it had a clean surface. The test which he employed to determine the purity of his materials was that which has been in use among toxicologists up to the present day, namely, before introducing the suspected substance, to boil a piece of clean copper with the diluted hydrochloric acid for four or five minutes; and if it did not acquire any tarnish or deposit, the copper and acid were to be regarded as sufficiently pure for the detection of the poison. Undoubtedly a negative result of this kind would be a proof either of the entire absence of arsenic from the metal itself, or, if present, that it was so intimately combined with the substance of the copper as not practically to affect the application of the process in a medico-

legal analysis. Resting upon this simple datum, Reinsch says of his method, "*Elle ne peut donner lieu à aucune méprise.*"¹ Dr. Christison, who has employed it during a period of fifteen years for detecting arsenic in the liver, says in his last edition on Poisons,² that "copper-leaf or copper-plate, worn thin by the action of diluted nitric acid or *fine copper gauze*, is the best form for use. . . . In all medico-legal inquiries it is necessary to perform a preliminary experiment with distilled water and the hydrochloric acid used, *lest the acid contain arsenic.* . . . It (the process) is not subject to any fallacy." If any additional authority is required to show how little toxicologists of great repute and enlarged experience suspected that arsenic was lurking in the copper which they were so frequently using, or that there was any better method of testing the purity of the materials than that originally devised by Reinsch, it is furnished to us in the extensive experience of Mr. Herapath, of Bristol. In an article already referred to, this gentleman thus describes his mode of operating:³

"I take pieces of copper wire about No. 13 size, and two and a half inches long; these I hammer on a polished plane for half their length, and having brought the suspected matters to a state of dryness, and boiled the *copper blade* in the pure hydrochloric acid, to prove that *it* (the acid) contains no metal capable of depositing, I introduce a portion of suspected matter, and continue the boiling," &c. If there is a deposit, it is removed by scraping, and tested. Referring to the fallacious results which occasionally arise from accidental causes, Mr. Herapath further says: "As much of the sulphuric acid of commerce, and nearly all such hydrochloric acid, and some commercial zinc, contains arsenic, nothing can excuse a toxicologist who attempts to try for arsenic if he has not previously experimented with *all* his reagents before he introduces the suspected matters."⁴

It is reasonable to suppose that when this paragraph was written Mr. Herapath had no suspicion that copper wire

¹ 'Annales d'Hygiène,' 1843, p. 452.

² 'Treatise on Poisons,' fourth edition, 1845, p. 272.

³ Ure's 'Dictionary of Arts,' Part i, 1859, p. 191.

⁴ Loc. cit.

known as No. 13 contained arsenic, or, indeed, that in employing or recommending it for Reinsch's process, there was any necessity of testing it for arsenic. He gives explicit directions for testing the acids and zinc for arsenic, but no suggestion for testing the copper. In short, Mr. Herapath, so far as the copper is concerned, adopts no other method of preliminary examination for arsenic than that propounded by Reinsch in 1841, which has been used by all toxicologists since that date. This, it is well known, consists in boiling the polished or clean copper with the diluted acid before adding any portion of the suspected poisonous material. Having procured from three of the first London chemical dealers three samples of the wire No. 13 size, as recommended and used by Mr. Herapath, I found in each sample a *larger proportion of arsenic* than that which existed in the copper-gauze used by Dr. Odling and myself in the Smethurst case.¹

¹ This case drew from Mr. Herapath, in the capacity of "amicus justitiæ," a letter, which was published in the 'Lancet' of September 3d, 1859, and in most of the medical and daily journals. It condemned in strong language the use of copper containing arsenic, and suggested that all convictions which had for twenty years taken place upon the use of Reinsch's process could be only regarded as judicial murders. Let the reader consider the value of such a condemnation coming from a man who, unfortunately for his appeal to justice, had himself during sixteen years employed and recommended for Reinsch's process a strongly arsenicated copper wire! It will be perceived, by his mode of operating, too, that not satisfied with depositing arsenic on the impure copper, he directs that the deposit should be continually scraped off as it is formed, thus mixing the impure copper with the supposed arsenical deposit. In this letter, Mr. Herapath states that the *one thousandth* part of a grain of arsenic is quite sufficient, by Reinsch's process, to furnish the five proofs which he requires for scientific evidence on a charge of murder. A few grains of his No. 13 wire will, under certain conditions, yield this quantity of arsenic, which, in ignorance of its presence as impurity, an analyst might easily assign to the liquid or solid examined. Measured by his own standard, and quoting his own words, "what shall be said of the convictions and executions which have taken place during sixteen years upon Mr. Herapath's evidence, if the same impure copper has been used by him in the process of Reinsch?"

Either Mr. Herapath knew that the No. 13 wire, which he employed and recommended, contained arsenic, or he did not. If he did know it, then he deceived the public and profession by the publication of his letter; if he did not know it, then, instead of acting as censor of others, he should have acknowledged with penitence his own chemical transgressions for the long period of sixteen years, and have thanked those who, for the first time, in 1859, pointed out to him the danger of the course which he was pursuing. If danger ever arises from the presence of

Men who should have a better knowledge of the subject, asserted that there was no novelty in the announcement of this universal presence of arsenic in the so-called purest forms of copper. The untruthfulness of this statement can only be appreciated by those who have taken pains to refer to the highest chemical authorities. It was known that arsenic was associated with the ores of copper; but there was a general belief, from the known volatility of arsenic (at 380°), and the repeated meltings which copper underwent in the process of refining (being each time heated to 1996°), that the whole of this arsenic was evolved; and that if it anywhere existed, it would be only in the coarse kinds of unrefined or commercial copper. Berzelius ('*Traité de Chimie*,' tome iii, p. 124), in an elaborate description of the properties of this metal and the mode of extracting it, makes no reference whatever to even the possible presence of arsenic as a contaminating ingredient in copper. Dumas, in his '*Traité de Chimie appliquée aux Arts*' (tome iii, page 472 *et seq.*), in giving a complete history of this

impurities in chemicals, that danger is undoubtedly incurred in the highest degree when a man is rashly prepared to swear to the presence of poison from the discovery of the *thousandth part of a grain*! Of Mr. Herapath's conduct and motives in this transaction, I shall only say "*Quem deus vult perdere prius dementat.*"

I cannot close this note without, for the sake of contrast, noticing the candid and honorable conduct of an excellent chemist and eminent practitioner, Dr. Douglas Maclagan, of Edinburgh, in reference to the discovery of this impurity in copper. Before the fact of the general presence of arsenic in copper had been made publicly known by the evidence given by Dr. Odling and myself at the trial of Smethurst in August, 1859, Dr. Maclagan had conducted a series of analyses for arsenic by Reinsch's process in a criminal case in Scotland, and had arrived at the conclusion that arsenic was present in the fluids and solids of the body. This case came to trial at Inverness, some months subsequently to the trial of Smethurst. After giving his evidence, and confirming his previous report, Dr. Maclagan requested the permission of the Court to correct it, by stating that by reason of certain matters which had become public since his first analyses, he had been induced to examine the copper which he had employed in his experiments, and he found it to contain arsenic. The proportion, however, was much smaller than that which he had extracted from the liver and other organs of the deceased. He had previously tested it in the manner in which, up to that time, it had been customary to test it, namely, by boiling it in diluted hydrochloric acid, but he had not until then looked for arsenic in its substance. This statement, showing the candour and honesty of the witness, was well received by the Court, and it did not subject this gentleman to that unlimited abuse which, on this side of the Tweed, it appears customary, among a certain class of barristers, to shower upon scientific witnesses.

metal, speaks of its being contaminated with lead and antimony, but he does not mention arsenic as an impurity. Among other works of great chemical authority may be enumerated those of Despretz, 'Elémens de Chimie,' i, 428; 'Ure's Dictionary,' art. "Copper;" Mitscherlich, 'Lehrbuch der Chemie,' ii, 187; Graham's 'Elements of Chemistry,' p. 579; Turner's 'Elements of Chemistry,' edited by Liebig and Gregory, 1847, p. 509; 'Elements of Chemistry,' by Sir Robert Kane, 1849, p. 552; Brande's 'Manual of Chemistry,' 1848, i, p. 820; Regnault, 'Cours Élémentaire de Chimie,' 1851, tome iii, p. 271; Gmelin's 'Handbook of Chemistry,' 1851, vol. v, p. 401; Abel and Bloxam's 'Handbook of Chemistry,' 1854, p. 409; Pereira's 'Elements of Materia Medica,' 1854, vol. i, p. 867. In these works of authority there is no reference to even the occasional or possible contamination of refined or any other kind of copper with arsenic; and two of the authors last mentioned, who are among the most recent writers on the science, state distinctly that "the best specimens of commercial copper are nearly pure; they contain only traces of iron." (Abel and Bloxam, *op. cit.*, p. 409.) Dr. Miller, in his 'Elements of Chemistry,' 1856, part ii, p. 980, does not speak of the contamination of refined copper by arsenic; but in reference to commercial copper, he states that it is very nearly pure; it contains minute quantities of arsenic, iron, and lead. It is worthy of notice, that among the above-mentioned chemical authorities there are three (Mr. Brande, Dr. Miller, and Messrs. Abel and Bloxam) who especially describe Reinsch's process for detecting arsenic, and they concur in stating that the only test required for ascertaining the purity of the materials used, is first to boil the copper in diluted hydrochloric acid, in order to ascertain their purity before employing them as tests (Brande, p. 933; Miller, p. 967; Abel and Bloxam, p. 571). Messrs. Abel and Bloxam recommend the use of ordinary copper-wire cleaned with concentrated nitric acid and washed. I might add to these authorities the names of Orfila, Devergie, Schneider, Chevallier,¹

¹ Among all the works in the English and French languages on the adulterations and impurities of substances employed in chemistry, medicine, and the arts, there is, perhaps, none which can compete in comprehensiveness with the 'Dictionnaire des Altérations et Falsifications des Substances Alimentaires, Medicamenteuses, et Com-

and other writers on toxicology, to prove either that the presence of arsenic in refined copper was entirely unknown as a chemical fact, or wholly ignored as an obstacle to the safe use of Reinsch's process for the detection of arsenic. Orfila, it is true, recommends, as a precaution, that the copper used should be heated in a tube, to ascertain whether it evolves arsenious acid, before boiling it with hydrochloric acid and the suspected substance. With this supposed precaution, which, it need hardly be said, is not, chemically speaking, sufficient to distinguish arsenical from non-arsenical copper, he relied upon the production of the metallic deposit as a perfectly safe and certain indication of the presence of arsenic in the substance

merciales,' by M. Chevallier, of which the third edition was published in 1857. It consists of two volumes, comprising nearly 1400 pages. M. Chevallier is much employed in Paris in medico-legal analyses. On referring to this work (tome i, pp. 19 and 51; tome ii, p. 672), it will be found that the author is especially careful to describe arsenic as an impurity in sulphuric and hydrochloric acids and in zinc; to explain the means for its detection and separation, and to caution analysts in reference to its presence in these substances; but he does not even refer to *copper*, although he has himself published papers on its application and use, in reference to Reinsch's process. The only inference to be drawn from this omission is, that he either was not aware of the existence of arsenic in copper, or that its presence exerted so little influence on the uses of this metal as to render it unnecessary to notice it as an impurity.

The fact that all the commercial and nearly all the medicinal *sulphate of copper* contains arsenic, is also unnoticed by this writer. At p. 467, tome ii, he merely refers to the presence of sulphates of iron and zinc in sulphate of copper. There is so much arsenic in the ordinary sulphate, that ten grains of the crystals will commonly yield clear evidence of its presence. Other writers of repute on *Materia Medica* have, like M. Chevallier, overlooked this fact. Thus, Pereira ('*Materia Medica*,' i, p. 872) describes traces of sulphate of iron as the only impurity. The presence of this arsenical impurity may have an important bearing on evidence. If a man has taken large doses of sulphate of copper as an emetic and dies, arsenic may be found in the contents of his stomach, although none may have been administered. Chemists relying upon thousandths of grains may thus be deceived, and mislead a Court of law by their evidence. It is not a little remarkable that those who have condemned the use of copper containing arsenic, have either ignorantly or knowingly employed the sulphate of copper as a test for arsenic, without having previously tested this test for the poison itself. It is true that the quantity of arsenic present is small, and is not likely to affect the results, as the test is ordinarily used; but it is clear, if metallic copper is condemned because it contains traces of arsenic, no salt of copper can escape condemnation for a similar reason. It is the presence of a large quantity of arsenic in the commercial sulphate which is the cause of the occasional deposition of arsenic with copper by electrolysis.

examined.¹ Flandin, who was opposed to the use of any process for detecting arsenic excepting his own, objected to Reinsch's method, not on the ground of arsenic being possibly conveyed to the liquid by copper, but because it was less delicate than the process of carbonization by sulphuric acid.² Galtier, in his '*Traité de Toxicologie*,' 1855, i, p. 343, describes Reinsch's process, and merely requires that the copper should be *clean* and the diluted acid pure. Devergie speaks of it as a process but little employed, and simply points out that *clean copper* is required for the deposition of the arsenic.³

In fact, whether among English or French and German writers on chemistry and toxicology, there is not one who has ever pointed out, or even suspected, that this process would lead to error by reason of the universal presence of arsenic in copper, commercial or refined, which is accessible to the chemist.⁴ All have hitherto relied upon the cleanness of the surface of the copper used, and the method of testing the acid and copper first pointed out by Reinsch. As a general rule, this is quite sufficient. There is no liability to fallacy unless the copper is used on a large scale, and there is an acid or salt present which acts upon and dissolves the impure metal. Pending its solution, the atoms of arsenic, combined with it as arsenide or arseniuret, are set free, and may thus attach themselves to the clean surface of the undissolved copper. It is clear that if the presence of a minute quantity of arsenic in copper presents that

¹ '*Traité de Toxicologie*,' fifth edition, 1852, tome i, p. 521.

² '*Traité des Poisons*,' i, 625, 1846.

³ '*Médecine Légale*,' Paris, 1852, tome iii, p. 460.

⁴ That wisdom which is almost invariably manifested after an event was shown soon after the trial of Smethurst, in comments upon the chemical evidence. It was suggested by one chemist that the copper-*gauze* which Dr. Odling and I had been in the habit of using for some years in the lectures on Chemistry and the demonstrations on Practical chemistry at Guy's Hospital was of an arsenical nature, while copper-*foil* or *wire* either was or might be easily obtained free from arsenic; that every chemist knew there was arsenic in copper, and that no one but ourselves had employed Reinsch's process without first dissolving a portion of the copper in an acid or in chlorine, and testing the salt thus produced for arsenic. It was forced upon the attention of the Court that one of the chemists for the defence had always taken especial care to use electrotpe copper, as if this fact was a guarantee against its containing any arsenic. (See p. 230.) In short, whatever may have been the motive animating these critics, their statements, as it will be seen from the authorities quoted, displayed either great ignorance or great untruthfulness.

great risk of fallacy, which some chemists have recently endeavoured to impress on the public mind, no one of the numerous analyses for arsenic by Reinsch's process, which have been undertaken during the last twenty years, could have been made without the inevitable discovery of arsenic. In short, if a source of fallacy, it would have led to the constant and inevitable discovery of arsenic in every solid and liquid submitted to examination. Analysts who have had much experience in the use of this process, will bear me out in the statement, that in employing samples of the same copper and acid,—for one affirmative result in which arsenic is discovered, there will probably be four or five negative results, in which no deposit whatever has taken place on the arsenical copper, and no arsenic was detected. By boiling successive quantities of the same arsenicated copper in the same acid liquid containing arsenic, the whole of the free arsenic is finally removed; the deposits on the metal become less and less decided, they at length cease altogether, and the last portion of copper put into the liquid comes out nearly as bright as when introduced, or if at all dull on the surface, this dulness arises, not from arsenic, but from oxidation, as a result of long boiling. It is obvious, that if the arsenic came from the copper itself, and not from any extraneous source, instead of the arsenic diminishing on each introduction of the copper, it would go on increasing in proportion to the quantity of the metal employed in the analysis. The hundreds of negative results which have been obtained by experienced analysts, establish the untruthfulness of the assertion, that the process, as it is commonly employed, is attended with a serious risk of fallacy, even when copper containing arsenic is unknowingly used. The analyses performed by Reinsch, Gaultier de Claubry, Orfila, Christison, MacLagan, Geoghegan, Watson, Rey, Penny, and others, are as unassailable on this ground as those which have been performed by Mr. Herapath himself, even with his No. 18 commercial wire, *i.e.* assuming that the copper and acid have been boiled together, and no deposit formed before the suspected substance was added.

There is, however, great danger in endeavouring to conceal or distort a scientific truth, especially when, as experience now shows, reliance is placed upon false criteria to determine the presence or absence of arsenic in any given sample of copper.

In the letter already referred to, Mr. Herapath states that the hundredth part of a grain of arsenic contained in the quantity of copper gauze (ten grains) used by Dr. Odling and myself in one of the analyses in Smethurst's case, would have rendered it (the copper) so *brittle*, that it could not be drawn into wire at all, much less into fine wire fit for gauze. The copper-wire (woven in gauze) which led to this fallacious result was not more than the 1-200th of an inch in diameter, and probably even less. The gauze included about 10,000 spaces or apertures in the square inch. We had the benefit of the opinion of an experienced chemist (Mr. Brande) as to the quantity of arsenic separated from the gauze in this experiment; it was considered to be equivalent to a proportion of at least 1-1000th part of arsenic. It caused some surprise to Mr. Brande, as well as to ourselves, that so much arsenic, in a well-defined ring of octahedral crystals, should have been procured from such highly flexible and refined copper as that which we employed in our experiment. It was a new fact to him and to ourselves, that copper in so highly ductile and flexible a condition should be so strongly impregnated with arsenic. It is clear from Mr. Herapath's reliance on exceeding brittleness as a test of the presence of a small quantity of arsenic in copper, that he would have drawn the same inference which, in the first instance, we felt constrained to draw, namely, that no arsenic could be contained in a wire so fine and flexible as that which we used. Other authorities share Mr. Herapath's erroneous opinion in reference to this matter. Gmelin says, on the combination of arsenic with copper,¹ that "copper alloyed with 0.15 per cent. of arsenic, becomes somewhat brittle when cold, and very brittle at a red heat. Regnault states, that copper containing arsenic in small quantity becomes whitish and very brittle; and Abel says, that a very small quantity of arsenic injures the ductility of the metal, rendering it whitish, at the same time it is to be somewhat brittle. Nothing can be more unreasonable than a reliance upon these alleged physical effects of arsenic on copper, as evidence of the presence or absence of arsenic in a substance. The facts now ascertained are simply the reverse, namely, that copper may contain sufficient arsenic to lead to fallacious

¹ 'Handbook of Chemistry,' tome v, p. 470.

results in analysis, without any change of colour, and without losing any of its malleability or ductility; while, when entirely deprived of arsenic and other metals, it has been found so brittle that, even after several meltings and annealings, it was impossible to roll it into thin foil.¹ From some experiments recently made by Dr. Hofmann and Dr. Matthiessen on the conductivity of copper, it would appear that the electric conductive power of ductile copper is materially affected by the presence of small quantities of arsenic, as well as of other metals and metalloids. An analysis of the black precipitate formed during the electrolytic decomposition of sulphate of copper by the galvanic current, has led to the discovery of twelve metals, which must have been contained in the original copper. One hundred parts of this black sediment yielded 7·40 parts of arsenic. The other metals found in variable proportions were antimony (9·22 per cent.), platinum, gold, silver, lead, iron, nickel, cobalt, vanadium, and tin.² It now becomes, indeed, a serious question whether purity in regard to this and other metals is not merely a relative term; and whether the discovery of these metallic impurities does not depend on the quantity of copper or zinc submitted to analysis at any one time.

I am indebted to Dr. Matthiessen, of Torrington Street, London, a skilled metallurgical chemist, for some useful facts regarding the effects of arsenic on copper. He informs me that there is no test so delicate or certain for the detection of this impurity in copper, as its power of conducting the electric current. While pure copper has a maximum power of conduction, the presence in it of the smallest traces of arsenic, &c., scarcely discoverable by chemical processes, reduces the conducting power to a measurable extent. He has given to me, 1st, a sample of copper containing 5·4 per cent. of arsenic. Its colour is pale red, it has evidently undergone a change; but its ductility has been so little affected that it has been drawn into a wire only 1-80th of an inch in thickness. It is flexible, but

¹ I sent a sample of copper without arsenic to my friend Mr. Brande, for the purpose of having it rolled under the Mint presses. He writes to me, that "there is an inherent *hardness* and *brittleness* about it which we have in vain attempted by repeated fusions, &c., to get rid of, so that it has ultimately produced a riband full of flaws and fissures."

² 'Proceedings of the Royal Society,' tome x, No. 38, 1860, p. 302.

breaks when suddenly bent. 2. A wire containing 2·8 per cent. of arsenic having a diameter of about the 1-100th of an inch. It has the usual copper-red colour, and can be bent and twisted upon itself without breaking. It manifests no more brittleness than ordinary copper-wire of the same thickness. Although it contains nearly 1-33d of its weight of arsenic, no one, judging by its appearance and physical properties, would entertain a suspicion of the presence of this substance. 3. A third wire of Spanish copper containing 2 per cent. of arsenic. It has about the same diameter as No. 2. It is perfectly flexible, and manifests no brittleness whatever. 4. A sample of fine British copper-wire as it is commonly sold, with traces of arsenic. It is of about the same diameter, but is not so elastic as 2 and 3. Let the reader compare these facts with the following statements contained in Mr. Herapath's letter¹—"the hundredth part of a grain of arsenic in that quantity (ten grains) of copper, would render it so brittle that it *could not be drawn into wire at all*, much less into fine wire fit for gauze." It is obvious that this chemist is either entirely unacquainted with the properties of copper containing arsenic as an alloy, or that he relies upon the general ignorance of the public and profession in reference to such matters, to publish a statement wholly opposed to facts.

Having recently examined not fewer than forty samples of copper, as it is employed by chemists in the form of wire of various sizes, of foil of various thicknesses, and of gauze, coarse and fine, I have found arsenic in all of them, and in some instances in comparatively large proportion. These samples were procured from dealers in this metropolis, from various parts of England, from Scotland and Ireland. Some of them have been forwarded to me by medical practitioners who had employed them as *pure* in medico-legal analyses, while some samples of gauze and foil had been sold as pure by dealers. In every instance arsenic was found in the copper; and there is no other conclusion to be drawn than that all the copper used in commerce, the arts, and chemistry, refined or unrefined, contains arsenic in such proportion, as when the metal is dissolved or destroyed, to render it unfit for Reinsch's process.² Mr.

¹ 'Lancet,' September 3, 1859, p. 248.

² Since writing the above, I have met with a passage in Will's 'Analyse Chi-

Brande stated, in his evidence at the trial of Smethurst, that this was to him a new fact in science, and it was equally new to all who had the candour and honesty to avow it, and who were not ashamed to acknowledge that they had been in the habit of using copper without applying any other method of testing it before use than that which was originally suggested by Reinsch. On this occasion, I procured from five gentlemen, of great repute in the three kingdoms, as analysts in cases of poisoning, samples of the copper which they had been in the habit of employing in their analyses, since the introduction of Reinsch's process. In each instance, arsenic was detected in the copper, and in two of the samples the proportion was greater than in the copper gauze which had been employed in our analysis.

It was asserted on the part of the defence in Smethurst's case, that *electrotype* copper was always pure, and that this could easily be procured. In order to test the accuracy of this statement, I have, since the trial, made an examination of seven samples of electrotype copper, three of which were prepared by myself, one was prepared by a respectable London firm, and another sample was procured from Elkington's electro-plating factory, at Birmingham. Two others were given to me by friends. In five of these no arsenic was detected; in the sixth, a small quantity was found; and in that which in richness of colour and flexibility surpassed all the other samples, namely, Elkington's copper, known under the name of "copper-edgings," arsenic was detected in well-marked proportion. The purity of electrotype copper cannot, therefore, be taken for granted:—every sample should be tested before it can be pronounced to be free from arsenic. The purity or impurity of the deposited copper no doubt depends on the purity of the sulphate employed, and the rapidity of deposit.¹ Mr. Dugald Campbell has furnished me with the results of his experience in the subjoined letter.

mique,' translated by Risler (1858), in which, in speaking of the diffusion of arsenic, he says, "Ou on rencontre des traces presque toujours dans le soufre, le fer, le cuivre, l'étain et l'antimoine."

¹ The above-mentioned facts show how extensively arsenic is diffused. Our copper coinage contains a large proportion. I have detected arsenic in the copper coinage of all our sovereigns, from the present time to the reign of George II. I found it, but in smaller proportion, in a coin of the reign of Augustus Cæsar; and in a portion of brass from a sepulchral inscription of the reign of Henry V (1416).

“ Arsenic in Copper.

“ In compliance with your request, I now write to you the results of my examination of twenty samples of copper, which were all sold as *pure*, and, in many instances, were specially stated to be free from arsenic.

“ Of these samples, eight were said to be *electrotype* copper ; and, from their appearance, I should say they were. Four out of the eight were said to have come from Germany.

“ Some of these samples I had from friends, and the remainder were purchased in London from different sources of high respectability.

“ In every one of these samples I found the presence of arsenic, higher in some than in others, but unmistakeable in all. I do not say that the arsenic was in such quantities as in ordinary circumstances to mislead an experienced person in detecting arsenic in a substance by Reinsch's test ; still in fluids containing oxidizing acids, and when it was requisite to detect minute quantities of arsenic, I think the quantity of arsenic in even the purest of these eight coppers, would interfere with the test.

“ Of the remaining twelve samples, some were purchased in London from undoubted sources of respectability, others were

All our copper culinary utensils contain it ; and when these are corroded or destroyed by acids, salts, or fat, arsenic is set free. The arsenic is deposited with the insoluble copper salt, and may be detected in it. Thus, in the insoluble oxychloride of copper deposited as a result of the action of common salt on copper under exposure to air, I have found arsenic, but not in the liquid. Salt fish cooked and allowed to cool in a copper vessel, may thus become impregnated with arsenic. Brass contains a large proportion of arsenic, derived from the zinc as well as the copper. As brass nails and plates are frequently and profusely used for coffins, insoluble cupreous salts containing arsenic, may be formed during the decay of the body, and become intermixed with the remains. This is a point which requires looking to when chemists rely upon thousandths of grains, and they are engaged in analysing the remains of the dead after some years' interment. In an exhumation of a body after nearly two years' burial, at which I was present, I noticed on the front of the dress covering the body, a large brass button, which had become incrustated with a blue deposit of hydrated oxide and carbonate of copper, heightened in colour by the ammonia of decomposition. I have no doubt that had this been tested it would have yielded arsenic. Nickel silver, containing half its weight of copper and about one third of its weight of zinc, also contains arsenic. The native subchloride of copper, obtained from the Atacama desert in Peru, did not yield any trace of arsenic.

obtained through friends at Bristol, Liverpool, Edinburgh, and Glasgow. Two out of the twelve were copper-gauze—the remaining ten were foil of different thicknesses.

“In all these samples of copper, arsenic was present in distinct quantity, and, as in the electrotpe samples, there was a variability as to quantity: but the sample most free from arsenic, contained much more than the most contaminated of the electrotpe samples. I am of opinion that some of the samples were so impure from the presence of arsenic, as even to mislead an experienced person, when testing for this substance under ordinary circumstances.

“I remain, &c.,

“August 13th, 1860.

“DUGALD CAMPBELL.

“Dr. A. S. Taylor.”

If these facts be admitted, the inquiry naturally follows: Is there any risk in employing copper containing arsenic, for separating this substance in cases of poisoning? The answer may be anticipated. There is no risk, unless the copper, during the process, is brought to a state of solution; and of this fact the operator is immediately informed by the disappearance of the metal and by the liquid acquiring a deep-green colour. Hence, while the negative results which the process so frequently furnishes, afford an unquestionable proof that the copper may be used with safety, the operator has clear evidence when there is risk, by the solution of the copper in the acid liquid. If the copper employed is unaltered in weight, and is not to any perceptible extent dissolved, it is obvious that the liquid submitted to analysis cannot have received any impregnation of arsenic from the copper employed; and, if, under these circumstances, arsenic is deposited on the copper, then that poison must have been present in the liquid submitted to examination. Cold hydrochloric acid, if strong and not too freely exposed to air, produces no deposit or change in the appearance of bright copper, even after forty-eight hours immersion and exposure. Whether the copper be pure or arsenicated, there is no perceptible difference. The upper stratum of the liquid has a slight greenish yellow tint, arising from the oxidation and solution of a small quantity of copper. If the polished copper is immersed in an acid diluted with

eight parts of water, it will be found after forty-eight hours that the whole of the liquid has a greenish colour, from the formation of chloride; the copper, if arsenicated, is coated with a thick dark-coloured deposit; while, if pure, it is of a reddish brown colour. The surface of the metal in either case will be found much corroded, and a number of tetrahedral crystals of subchloride of copper are scattered over it. I have not been able to procure crystals of arsenious acid by heating impure copper thus coated, and I have not detected any arsenic in the acid liquid; the amount of arsenicated copper dissolved is probably too small to furnish any evidence of arsenic. These results confirm Reinsch's statement that the concentrated acid, *cæteris paribus*, exerts a less powerful action on copper than the diluted acid; they also prove that arsenicated copper should not be allowed to remain for a long time in the acid liquid. The tarnish thus formed might, unless properly tested, be mistaken for arsenic or conceal an arsenical deposit. They prove, however, that the alloy of arsenic and copper (arsenide) is not so decomposed by cold diluted hydrochloric acid, as to set free any arsenious acid in the liquid. In short, the danger of any fallacy in the ordinary use of the process, arises from the presence of arsenic as an impurity in the acid, and not from arsenic contained as impurity in the copper. But for this fact, no chemist would ever have met with negative results in employing copper in the state in which it has hitherto been used.¹

Hydrochloric acid, diluted with from six to ten parts of water, has but a feeble action on copper, even after long boiling. A trace of this metal may, under these circumstances, be found in the liquid. If, however, the oxide of arsenic or antimony should be present in the liquid, a portion of copper is immediately dissolved, and an equivalent portion of arsenic or antimony is deposited. So soon as the copper is completely coated, the solvent action is arrested. In order to determine

¹ In the case of Smethurst, out of seventy-six analyses in which the process of Reinsch was resorted to, arsenic was detected in only two instances. In one of these, the copper was entirely dissolved by reason of the unexpected presence of chlorate of potash, and there was no doubt that from subsequent investigation, the arsenic here detected, proceeded from the dissolved copper. In the other instance the copper was *not* dissolved, but was coated in a few minutes, as is usual in cases in which arsenic is actually present as a poison.

how far arsenicated copper is liable to undergo solution, and to set free arsenic as a result of boiling in pure hydrochloric acid diluted, the following experiment was performed. A quantity of copper-foil and gauze, equivalent to 39·4 grains in weight, was boiled in a retort with a mixture of one ounce of pure hydrochloric acid, and eight ounces of water. The boiling was continued for half an hour, and the distilled acid liquid was collected in a cool receiver. This amounted to twelve fluid-drachms. It contained no trace of copper; and on a careful examination of the liquid by Marsh's and Reinsch's processes, there was not the slightest trace of arsenic in it. The large quantity of acid liquid left in the retort was found to contain a small quantity of copper; but there was no arsenic dissolved in it. The undissolved copper, when washed and examined by the microscope, had no metallic deposit upon it: It was unchanged in colour, but presented slight marks of corrosion. A quantity of it heated in a tube gave no sublimate.

When arsenicated copper is boiled in the diluted acid for five minutes,—a period within which arsenic, if present, is commonly manifested by some deposit or change of colour on the surface of the metal, no copper is dissolved. The metal retains its usual polish and lustre. If a small portion of oxide of arsenic or antimony be now added to the boiling acid liquid, there is an immediate deposit on the clean copper surface; and copper, in small quantity, will be found dissolved in the liquid by that delicate test—ferrocyanide of potassium. It is, therefore, obvious that the metallic oxide (*i. e.* the poison itself) brings about the solution of the copper, but not to an extent to eliminate arsenic so as to affect the process. It has been alleged that the accidental presence of certain salts, or organic liquids not containing arsenic, would lead to a sufficient solution of the copper to give rise to a deposit of arsenic on that metal. This action has been loosely ascribed to alkaline nitrates, phosphates, sulphates, and chlorides,—salts which may be occasionally met with in organic liquids. A grain of each of these salts was dissolved in two drachms of diluted hydrochloric acid, in the proportions used for the precipitation of arsenic (1 : 8). The solution was brought to the boiling point, and boiled for a few minutes in contact with a slip of

polished copper. No copper was dissolved in any one instance, and the metal retained its lustre. On adding a minute portion of arsenic to the liquid, the metallic copper was speedily coated, and traces of a salt of copper were now, for the first time, found in the liquid. When to a similar quantity of acid liquid, in which copper was immersed, a fragment of chlorate of potash was added, there was an immediate solution of a portion of the metal; a fact rendered evident by the production of a green colour, and by the application of the usual tests for copper to the liquid.

While the presence of a sulphate, nitrate, chloride, or phosphate does not affect the process, so long as a properly diluted acid is employed for a proper time, it was found that an alkaline chlorate, even in small quantity, caused a rapid solution of the copper, and in proportion to the amount of this solvent action, a liberation of arsenic from the arsenicated copper. Owing to this chemical action of a chlorate on copper, it has been contended that Reinsch's process ought never to be employed when such a salt is present. Mr. Herapath affirms that "Reinsch's process is not applicable where nitrates or chlorates are present."¹ With respect to the nitrates, it admits of distinct proof that they present no objection when a properly diluted acid is used; and with regard to the chlorate, the process is unobjectionable, provided pure copper be used. The operator, in using copper free from arsenic, has only to saturate the liquid with the metal, and the last portion of copper put into it will effectually remove the whole of the arsenic, as well as any antimony that may be present. It is a good method of detecting minute traces of arsenic or antimony in copper; and one free from all objection, provided the hydrochloric and the chlorate are pure. The only circumstance which would render Reinsch's process inapplicable to the separation of arsenic in the presence of a chlorate, is the use of copper containing arsenic, like the No. 13 wire or the dial-plate or foil, as it is commonly sold. It is only the analyst, who has habitually and knowingly used arsenicated copper, who can treat the presence of a chlorate in an organic liquid, as a serious obstacle to the employment of this process.²

¹ Letter in the 'Lancet,' Sept. 3, 1859, p. 248.

² In the Smethurst case, arsenic was deposited on a piece of copper gauze, from one

While, however, there is no reason to believe that the use of ordinary copper is attended with any risk in the employment of Reinsch's process, merely because it contains traces of arsenic in intimate chemical union, it may be a question whether, out of deference to public opinion, a substance containing arsenic in any

out of three evacuations passed by the deceased a few days before her death. The gauze employed was undissolved after boiling; and unchanged in form and substance. There was no indication that any portion of it had been dissolved; and assuming that it could coat itself with arsenic in the acid liquid, without undergoing solution (an impossibility if free arsenic was not present), it is quite certain from its small size, that it would not contain enough arsenic to give such a deposit as was ultimately procured upon it. A portion of this deposit yielded a well-marked sublimate of octahedral crystals. Some ingenious chemists suggested that a phosphate, nitrate, or chlorate, might have been present on this evacuation, have dissolved the arsenic out of the copper (without dissolving or destroying the copper itself), and thus have given rise to a fallacy. The fallacy was in their own imaginations, and based on a preconceived desire to account for a result by any theory, excepting the true one; namely, that arsenic in small quantity was present in the liquid. Two other evacuations examined by the same materials yielded no arsenic (they had been passed before the symptoms resembling arsenical poisoning had supervened), yet there was no reason to suppose that these should have been deficient in the salts assumed to be present in the one in which arsenic was detected. The latter evacuation contained blood and mucus, such as usually accompany arsenical poisoning. There was no blood and but little mucus in the two evacuations from which the copper-gauze came out without any arsenical deposit upon it.

I must here notice another theoretical objection to the use of Reinsch's process when a chlorate is present, namely, that arsenic may be lost by its volatilization as chloride. This presents no difficulty: the operator, if he believes in the reality of the objection, has only to carry on the boiling in a retort, and to collect the distilled product in a receiver. The chloride of arsenic, however, is not likely to be carried over. But is this a fact, or is it a speculation? In the correspondence published in the medical journals, it was set down as a fact. On distilling a mixture consisting of seven grains of chlorate of potash, with one drachm of pure hydrochloric acid, and eight drachms of water (the usual proportions for separating arsenic), and adding to this twenty-five grains of arsenicated copper gauze cut into fine pieces, the acid liquid collected in the receiver after the operation had continued for more than an hour, contained not a trace of arsenic. Pure zinc was placed in it, and the gas produced was passed into a solution of nitrate of silver. There was no change, even after the zinc had been exhausted. The arsenic is, in fact, converted to arsenic acid and retained in the retort as arseniate of potash, in the midst of the diluted acid and of the chloride of copper, formed at the expense of the gauze. Even if chloride of arsenic were produced, it would be deposited on the undissolved copper.

If, therefore, Reinsch's process has hitherto been avoided under these circumstances, because it might lead to the loss of arsenic,—this is an error; if, because it might introduce arsenic into the liquid under examination, then this implies that the operator must have been in the habit of knowingly using an arsenicated compound of copper for the separation of arsenic.

form, or in any proportion, should be used for the detection and separation of this poison. In several medico-legal cases which have occurred since the universal existence of this impurity has been made known, the ordinary copper, in gauze and foil, has been employed by gentlemen who, at the time, believed they were using pure copper; they have relied for purity only on the negative mode of testing the metal suggested by Reinsch. A chemist who does this must always incur some risk, and the result may be, that a jury will be induced to reject his evidence, simply because he has employed an article actually containing the poison for which he was seeking. Whatever explanation he may give as to the non-solution of the copper, and the proportion of arsenic found, being much greater than any arsenic contained in the copper which he used could possibly account for, it may always be suggested that he actually put the arsenic into the liquid. This equally applies to the use of the impure metal for the detection of antimony, as antimony is not an uncommon impurity in copper. To meet this objection, it will therefore be absolutely necessary, in future, to seek for copper free from either arsenic or antimony.

That this view of the facts is based on pure prejudice is undeniable, and a single chemical illustration will prove it. Standard gold contains more than eight per cent. of copper. Strong nitric acid may be boiled in a golden capsule made of this alloy without removing a particle of copper. If, now, any organic liquid containing a soluble salt of copper be placed in the capsule, and a slip of zinc be brought into contact with the gold through the acid liquid, the copper is removed from the solution, and is deposited on the gold. The capsule may be washed with water, and the film of metallic copper subsequently be dissolved in nitric acid and tested in the usual manner. No chemist would object to use the gold in such a case, merely because it contained copper; he would be governed by the fact, that under the circumstances no copper could possibly be derived from the alloy. If the substance used to detect copper was a solvent for gold, of course this mode of testing would be improper. If in a research for poisons we are merely to regard the presence of impurity in substances, without reference to the results, no analyses could be performed. It is very rare to find sulphuric acid, hydrochloric acid, or zinc, absolutely

free from arsenic. Much depends on the quantity of each article used for the purposes of testing purity. Every specimen of zinc, if examined in sufficient quantity, would probably yield arsenic; although this metal may be obtained, and is obtained, sufficiently pure for use in Marsh's process. Mr. Bloxam, in a paper recently published on the detection of poisons by electrolysis,¹ says, "The occasional presence of arsenic in the sulphuric acid, and of both arsenic and antimony in the zinc, has always been a serious objection to the use of Marsh's process; and although the hydrogen evolved at the beginning of the experiment may be carefully examined before introducing the suspected liquid, the operator always proceeds upon the assumption that the zinc is perfectly homogeneous, and that it is impossible for arsenic or antimony which had eluded detection in the first portion of hydrogen evolved, to become apparent when the mass of zinc has entered into solution." Instances have occurred in which analysts have been satisfied with testing their acids in small quantities, while they have afterwards employed them for analyses in very large quantities. It would be difficult to draw the line between a pure and impure article, and insist upon absolute purity. There is so much inconsistency in the statements of chemists regarding these matters, that the public are mystified, and a feeling of distrust is created in all scientific processes. One chemist who has himself used arsenical copper for sixteen years, condemns its use by others when the fact is first made public; another, who professes to use electrotpe copper, from theoretical notions regarding its absolute purity, has adopted, unknowingly, the constant practice of using arsenical sulphate of copper as a test for arsenic! While he would probably meet any objection to the use of this salt by asserting that the arsenic is in too small quantity to affect the results, he would, without reference to results or quantity, condemn the use of the metal itself (containing arsenic) for the detection of this poison. The only plan now open to an analyst is, to seek for the purest articles which he can obtain, and to test their purity by every conceivable method before he resorts to their use. If he desires to escape the censure of the public, and the uncharitable criticisms of some fellow-labourers in the same branch of research,

¹ 'Quarterly Journal of the Chemical Society,' 1859-60.

he must go beyond the ordinary routine of testing his materials. He must look for substances, the presence of which they have hitherto ignored or disregarded; or, in the end, some of them will be found to claim credit, however unjustly, for a degree of caution which they have never themselves exercised. Owing to the want of general knowledge on such subjects, they may for a time succeed in their object, and divert public attention from their own proceedings.

Committunt eadem diverso crimina fato,
Ille crucem pretium sceleris tulit, hic diadema.

As a rule, the purity of no chemical substance should be taken for granted in conducting medico-legal investigations; and the operator should, in fairness, always test a quantity of the substance equal to that which he is about to employ in an analysis.

Methods of detecting Arsenic in Copper.

There has hitherto been great difficulty in detecting small quantities of arsenic in copper, and this may account for the fact, that samples of copper are sold as pure, and are pronounced to be free from arsenic, when a more careful research would have demonstrated the presence of this substance. This difficulty may be appreciated from the fact, that when samples of the arsenicated copper-gauze used in the Smethurst case were forwarded to five experienced analysts in England, Scotland, and Ireland, three succeeded and two failed in detecting arsenic in it. A sample of Burra Burra copper supplied to the Royal Mint as absolutely free from arsenic, was found (by a process to be presently explained) to contain traces of that substance. Some Swedish copper which had been reserved as pure by a distinguished chemist, was found, on analysis, to be arsenical. The detection of the arsenic depends entirely on the method pursued.

The first plan which I adopted successfully, consisted in oxidizing the copper by nitric acid, evaporating the acid liquid to dryness, and then heating the residue to procure the black oxide, and, at the same time, to convert the arsenic, if present, to arsenic acid. This acid was subsequently detected in the

residue by digestion in water, and the addition of nitrate of silver.

Another plan, proposed and employed by Dr. Odling, clearly showed the presence of arsenic in a small quantity of gauze, foil, or wire. The copper was entirely dissolved by the aid of hydrochloric acid and a weak solution of chlorate of potash. The surplus chlorine was removed by the gradual addition of small quantities of bisulphite of soda, and the sulphurous acid derived from this salt was removed by boiling,—the freedom of the vapour from the acid being indicated by holding in the current, starch-paper saturated with iodic acid. Reinsch's process was then applied to the liquid, and if the copper under examination contained arsenic, a deposit of arsenic was obtained in the usual way on a piece of copper.

There is no chemical objection to this method; but seeing that several substances are employed in the analysis, and that a mixture of salts resulted, it appeared to me preferable to convert the copper to a soluble chloride by digesting it in pure hydrochloric acid alone, and then from the known volatility of chloride of arsenic, to separate this from the chloride of copper by distillation. For this purpose, I found it necessary to expose the copper in a stratum of pure and concentrated hydrochloric acid contained in a saucer, the metal being partly immersed in the acid and partly exposed to the air. After two or three days' exposure, according to the thickness of the metal, a brown liquid, (a solution of subchloride of copper in hydrochloric acid) was obtained. In some experiments, the copper was entirely dissolved; in others, a portion was left. The weight of the residue, after washing and drying, deducted from the original weight employed, gave the amount of copper dissolved. The brown liquid was distilled to dryness in a flask or small retort, placed in a sand-bath, and the vapour was condensed in a flask or receiver containing a small quantity of distilled water. A perfectly clear solution of chloride of arsenic, or a mixture of hydrochloric and arsenious acids, was thus procured. When one part of this distillate was diluted with its volume of water and boiled, and a small piece of pure polished copper was introduced, the presence of arsenic was speedily indicated by the characteristic deposit on the bright metal. Another portion of the liquid was introduced into a Marsh's

apparatus, or a small flask with a bent tube fixed in its neck, and by the addition of pure zinc, arseniuretted hydrogen was easily procured from it and tested. When to a third portion a solution of chloride of gold was added, and the mixture boiled, the gold was, after a time, completely deposited. The weight of gold thus deposited supplies one method of calculating the quantity of arsenic present in the distillate.

Of the delicacy of this process for detecting arsenic, there will be, I think, no doubt on the part of those who try it; and it has this important advantage over other methods, that excepting the copper, the purity of which is to be tested, and hydrochloric acid, the purity of which may be easily determined by a preliminary experiment, no chemical is used. It is equally applicable to the detection of minute traces of arsenic in the sulphate and all the salts of copper, soluble or insoluble. It is only necessary to distil them with a sufficient quantity of pure hydrochloric acid. I had in vain sought for evidence of arsenic in some sulphate of copper by the use of Marsh's process; but on distilling only ten grains of the crystals with hydrochloric acid, chloride of arsenic was obtained in the receiver, and the presence of the poison was satisfactorily proved. In the course of the Smethurst analyses in July, 1859, Mr. Brande and Dr. Odling adopted, at my suggestion, this method of analysing some sulphate of copper pills for arsenic, and they both expressed their satisfaction with it as a safe and delicate process.

DISTILLATION PROCESS FOR ARSENIC.

The plan which, after many experiments, I feel justified in recommending for the separation and detection of arsenic in liquids and solids, whether organic or inorganic, is based, 1st, on the ready conversion of arsenic into *chloride*; 2d, the transformation of this compound to *hydride* by Marsh's process; 3d, the production of metallic arsenic, of arsenious and arsenic acids from the hydride; and 4th, testing the products. When once obtained in the state of chloride, the presence of arsenic admits of easy verification, either by resorting to the process of Reinsch or that of Marsh. The

quantity of arsenic present may also be determined either in this or a subsequent stage.

First stage—*conversion to Chloride*.—If the substance to be examined for arsenic is *solid*, it should be reduced to a fine powder, or cut into small pieces. In the analysis of the liver, spleen, or other soft organs, it will be proper to cut these into small portions, and to dry them either by a current of air or by the aid of a water-bath, so as to deprive them as much as possible of water. The complete elimination of the arsenic depends greatly on the perfect desiccation of the substance and the concentration of the acid, as the following experiments will show :

One grain of white arsenic was mixed with two drachms of pure hydrochloric acid, in which it was readily dissolved, and the solution was distilled to dryness. The acid liquid in the receiver measured three drachms, one drachm of water having been placed in it for the purpose of condensing the acid vapours. Arsenic was abundantly detected in the distillate by all the usual processes. The washings of the retort (for there was no apparent residue) gave a mere trace of arsenic, calculated not to exceed the 1-4000th part of a grain. When a similar quantity of arsenic was boiled with the diluted acid (1 to 8), it was not dissolved; and when distilled, the greater part was left in the retort. When the experiments were repeated in porcelain capsules, there was no residue from the strong acid, but an abundant residue from the diluted acid.

Nearly all the soft organs, including the muscles, contain from 60 to 70 per cent. of water; and this furnishes a great obstacle to the entire separation of the arsenic by distillation. In the analysis of liquids, such as the blood, urine or vomited matters, it is desirable to bring them to dryness by a water-bath before treating them with hydrochloric acid.

The substance, whatever may be its nature, having been brought to perfect dryness, is covered with concentrated hydrochloric acid, the purity of which has been previously tested by operating on an equal quantity, according to a method to be presently explained (p. 244). The quantity of pure hydrochloric acid used, must depend on the quantity of material for analysis. It should be sufficient to break up, dissolve, or mix freely with the whole of the solid. The mixture should be

made in a retort or flask fitted with a condensing-tube, and then gradually heated by a sand-bath, until the acid liquid begins to pass over. The retort or flask may be connected with a receiver closely fitting to it, and holding a small quantity of distilled water. The water in the receiver should be just sufficient to condense and fix the acid vapours. The receiver, as well as condensing-tube, should be kept cool by wetting its surface with cold water or otherwise. The perfect condensation of the distilled liquid is ensured by this arrangement.¹

The distillation may be carried to dryness on a sand-bath, or nearly so; and it may be sometimes advisable, in order to ensure the distillation of the whole of the arsenic as chloride, to add to the residue in the retort another portion of pure and concentrated hydrochloric acid, and again distil to dryness. I have, however, found that portions of dried liver and stomach give up every trace of arsenic by one distillation, when a sufficient quantity of hydrochloric acid has been used in the first instance, and the distillation has been slowly conducted by a regulated sand-bath heat.

Second stage—conversion of Chloride to Hydride.—The liquid in the receiver is a solution of chloride of arsenic in water, or, as some believe, a mixture of hydrochloric and arsenious acids. It is in general colourless, when care has been taken; or if slightly coloured yellow, this will not interfere with the subsequent steps of the analysis. It contains no amount of organic matter which can lead to frothing in Marsh's tube, or to any deceptive results from the combustion of the gas produced. There is no loss by volatility at ordinary temperatures, since the water retains the chloride of arsenic; but at the same time it is proper either to proceed immediately with

¹ As a substitute for a retort when the quantity of matter for distillation is not large, I have found a most convenient form of apparatus, to be a globular flask of thin glass, with a short neck. Into this is fitted a tube of hard glass, from two to three feet in length, and one quarter of an inch in the bore. It should just pass through the cork in the neck of the flask, and this end of the tube should be bevelled off obliquely to a point, in order to prevent any of the liquid in the flask from being carried over. The tube should be covered spirally with layers of blotting-paper (kept constantly wetted), for at least two feet of its length, and should terminate in a Florence flask, to which it is fitted by a cork. This flask should be kept cool by immersion in a basin of water, or by covering its surface with wet tow.

the examination of it, or to place it in a stoppered bottle to prevent loss by evaporation of the distillate. The arsenical liquid in this state may be preserved for examination at any future period.

If a quantitative analysis is required in this stage from a given weight of the organic solid or liquid, one third of this distilled liquid may be reserved for the purpose. Of the remaining two thirds, a small portion may be diluted with four or five parts of distilled water and boiled. When boiling, a piece of bright copper foil (free from arsenic) should be introduced. If there is chloride of arsenic in the liquid, even up to the 1-4000th of a grain, its presence will be indicated by a change of colour, and by the deposit of a dark metallic film on the copper. If the liquid should be too much diluted for this purpose, it may be concentrated on the polished copper, and the deposit will after a time be apparent. If the quantity of arsenic present is believed to be very small, the surface of copper introduced should be proportionably small.

The larger portion of the distilled liquid should now be introduced into a bottle or flask, the capacity of which must be regulated by the quantity of acid liquid to be examined. To the neck of this flask there should be fitted, by means of a soft cork, a hard glass tube of about a quarter of an inch in the bore. After rising an inch or two, it should be bent at a right angle, and carried horizontally for the length of a foot. It should then be bent at another right angle, for the convenience of dipping into liquids contained in glasses or tubes. The horizontal portion of the tube should be drawn out in three different places, until the diameter of the tube does not exceed the tenth of an inch. This allows of the collection of metallic deposits in a concentrated form, and on surfaces in which they may be easily examined and tested. This arrangement was, it appears, first proposed and employed by M. Lassaigne, in 1842.¹ Care should be taken to employ glass free from lead. The tube should resist a red heat without blackening.

A piece of pure zinc is now dropped into the bottle containing the distillate. If the action of the acid is too violent, a little water may be added, and the cork then fitted. Two

¹ 'Manuel Pratique de l'Appareil de Marsh,' par Chevallier, 1843, p. 119.

test glasses or tubes, the one containing about a drachm of moderately strong solution of nitrate of silver, the other about the same quantity of the strongest nitric acid containing nitrous acid (sp. gr. 1.522), should be at hand to receive the gas from the bent tube as it escapes.

The solution of *nitrate of silver* furnishes an excellent medium for detecting minute traces of arsenic. So soon as the air from the flask is removed, and the hydride of arsenic passes over, the solution of silver is blackened. This blackening is owing to the production of metallic silver which is precipitated with a trace of arsenic. The arsenic takes the oxygen of the silver salt and passes to the state of *arsenious acid*—the nitric acid being set free in the liquid. The solution of silver may not show any blackening or darkening from the passage of the gas even after half an hour. Under these circumstances, no arsenic is present. We have in this method, therefore, the best means for detecting any arsenical impurity in the hydrochloric and sulphuric acid or zinc that we employ; and before using these in any analysis, it would be desirable thus to test them by this process. Unless we obtain negative results by passing the hydrogen produced, into nitrate of silver, we cannot safely employ them.¹

Third stage—*production of arsenic and its oxygen compounds*.—The silver solution completely arrests the gas and oxidizes the arsenic. When the current has passed through it for some time, a strong heat may be applied to the horizontal portion of the conducting-tube about one quarter of an inch before each contracted space, beginning with that which is nearest to the flask evolving the gas. The hydride is decomposed at a full red heat, and metallic arsenic is deposited in a dark ring or crust on the interior of the glass, at a short distance from the spot which is heated. The appearance of this will be brown, black, or strongly metallic, according to the quantity of arsenic present, and the time during which the heat

¹ It not unfrequently happens, even in testing pure zinc, as well as pure acids (hydrochloric and sulphuric), by this method, that although, after a quarter of an hour, the solution of silver may show no darkening, a black ring will be formed on the inside of the extremity of the tube which dips into the solution. This is precipitated silver, probably caused by the presence of minute traces of arsenic or phosphorus.

is continued. Under these circumstances, hydrogen only escapes; but as the end of the tube is still immersed in the solution of nitrate of silver, no arsenic is lost. The operator may, at his pleasure, thus procure three separate metallic deposits on the three contracted portions of the horizontal tube. Having prepared another right-angled tube with a cork to fit the flask, this should be rapidly substituted for that in which the deposits are collected. More zinc may be added to the flask, if necessary, and the gas evolved should be allowed to exhaust itself in strong *nitric acid*. Not a trace of gas escapes through this strong acid:—the whole of the arsenic is arrested and converted to arsenic acid, which may be obtained by evaporating the nitric acid on a sand-bath.

Fourth stage—*testing the products*.—By the methods suggested, the hydride furnishes, 1st, as a result of decomposition by heat, a deposit or mirror of *metallic arsenic*; 2d, as a result of the action of nitrate of silver, *arsenious acid*; 3d, as a result of the action of nitric acid, *arsenic acid*.

1st. The conducting-tube should be divided into as many parts as there are metallic deposits. The contracted portion of the tube being sealed, the metallic deposit may be gently heated, and if it be due to arsenic a ring of octahedral crystals of arsenious acid, small but well-defined under the microscope, will be procured. If there are several metallic deposits, these may be broken up and heated in a wider tube. By this means sufficient arsenious acid may be procured to yield a solution of arsenic, which will give the usual yellow and green-coloured precipitates with the ammonio-nitrate of silver and the ammonio-sulphate of copper. There is, however, ample corroboration in the subsequent stages, without resorting to the liquid tests. 2d. *Arsenious acid* is obtained in solution by filtering the decomposed nitrate of silver into which the gas has been passed, and by precipitating the filtered liquid with a slight excess of pure hydrochloric acid, so as effectually to remove the undecomposed silver as chloride. When the precipitated chloride has completely subsided, the liquid may be again filtered until it is perfectly clear and free from any silver salt. In this state a current of washed sulphuretted hydrogen gas should be passed into it, when the well-known yellow sulphide of arsenic will be precipitated in greater or less quan-

tity, according to the quantity of arsenic present. Independently of the colour of the precipitate, which distinguishes sulphide of arsenic from all metals excepting cadmium, it will be found that it is dissolved by ammonia, and not dissolved by hydrochloric acid in the cold.¹ 3d. *Arsenic acid* is a product of the action of strong nitric acid on the hydride. It may be procured by evaporating to dryness on a sand-bath, in a small porcelain capsule, the nitric acid after it has been saturated by the current of arseniuretted hydrogen gas passed through it. When quite *dry*, it appears as a white residue, if the nitric acid was pure. It is fixed at the ordinary heat of a sand-bath, and, after exposure to air for a short time, it will become moist and deliquescent. It should be completely dried before any test is added to it, because the presence of traces of nitric acid may interfere with the action of the test. If not in a deliquescent state as the result of exposure, a small quantity of distilled water should be added, to detach the acid from the capsule. One or two drops of a strong solution of nitrate of silver should now be added, and, if the residue is arsenic acid, a brick-red precipitate of arseniate of silver will make itself visible. In place of the nitrate, a strong solution of ammonio-nitrate of silver may be employed, provided the ammonia is not in excess. This has the advantage of neutralizing the solvent effect of any nitric acid which may be adhering to the solid arsenic acid, and it reveals the presence of small quantities better than the nitrate.

With these combined results, it is conclusively proved that arsenic must have been present in the substance analyzed. We have here, in the production of metallic arsenic, and of its two acid compounds with oxygen, as well as in the conversion of these to sulphide of arsenic and arseniate of silver, the maximum of evidence which an analyst could desire. Beyond this it appears superfluous to carry the chemical proof. The combustion of the gas, as suggested by Marsh, with the collection of deposits from the flame, while it necessarily entails much loss, is not required in any stage. The decomposition of

¹ The sulphide of cadmium is affected in a contrary manner by these reagents. It is insoluble in ammonia, but soluble in hydrochloric acid. Cadmium could not be present: it cannot be distilled as chloride, and it does not combine with hydrogen to form a hydride.

the hydride by a red heat in a close tube answers all the purposes of combustion, without the risk of loss from the frequent opening of a stop-cock. A larger quantity of metallic arsenic can be thus obtained in one operation; and any gas which escapes decomposition, is arrested and decomposed by the nitrate of silver or nitric acid.

The quantity of arsenic present in the distillate may be so small as only slightly to darken a solution of nitrate of silver, and to yield a hair-brown film of metallic arsenic by heating the tube. In cases in which the quantity of arsenic is very small, it will be convenient to extemporize a Marsh's apparatus, by fitting to a test-tube a cork traversed by a funnel-tube and a short exit-piece bent at right angles. This should be connected with a piece of tubing containing broken chloride of calcium, so that the gas as it passes may be dried. A tube, drawn out for about two thirds of its length to almost a capillary bore, should be fitted by a cork to the other end of the chloride-of-calcium tube. Zinc is placed in the apparatus, the funnel-tube is then fitted, and the distillate, suspected to contain traces of arsenic, is poured through the funnel. The gas is tested by holding filtering-paper, wetted with a solution of nitrate of silver at the capillary aperture of the tube. If arsenic is present, a minute black spot appears. This may, however, be due to antimony. If owing to the presence of sulphur, the spot will be brown, and the gas will discolour paper moistened with a solution of acetate of lead.¹

¹ In all cases, it will be found convenient to dry the arseniuretted hydrogen gas by means of a chloride-of-calcium tube attached to the apparatus. A piece of lead-paper, introduced at the mouth of this tube, will effectually stop any sulphuretted hydrogen that may be produced. It may here be observed, that neither arseniuretted, antimonyuretted, nor phosphuretted hydrogen darkens a solution of acetate of lead; and it is always proper to test the gas by lead-paper applied to the open end of the conducting-tube, before passing the current into a solution of nitrate of silver. Sulphuretted hydrogen would otherwise cause thick black flakes in the solution, and might give rise to an error respecting the presence of arsenic.

In cases in which the quantity of arsenic is sufficiently large, a tube with a stop-cock may be resorted to. This gives a command over the rapidity of the current.

The zinc which has been used in one experiment is not fitted for use a second time. Some arsenic is always deposited upon it, which is evolved when hydrogen is again generated. I have substituted aluminum with hydrochloric acid as well as potash, but I have not found this new metal to present any advantages over zinc. It contains no arsenic, but much iron and carbon.

The tube may now be heated red-hot within half an inch of the contracted portion, taking care that the contracted or capillary part of the tube, which is to receive the arsenic, is not overheated. A metallic deposit of arsenic is soon formed in the narrow portion of the tube. From the 1-1000th to the 1-2000th of a grain of arsenic may have its presence thus indicated.

When the quantity of arsenic is at a minimum, no other evidence than this thin metallic deposit may be obtainable. In general, however, besides the metallic deposit as a result of heat, it will be found, by passing the gas through a bent tube into nitric acid until the acid liquid in the apparatus is exhausted, a sufficient quantity of arsenic acid may be obtained, on evaporation, to admit of the application of the silver test, and the production thereby of the red arseniate of silver.

Whether the arseniuretted hydrogen is coming over, or has ceased to come over, is a fact which can always be determined by the application of filtering-paper, wetted with the nitrate of silver, to the open end of the tube from which the gas is issuing.

Various experiments were tried in order to determine whether other reagents might be used for oxidizing arseniuretted hydrogen and producing arsenic acid, in a form for testing. Solutions of chlorine and of chloride of lime in water were found to stop it only partially. Nearly one half of the gas escaped decomposition. On evaporating the liquids to dryness, some time after arseniuretted hydrogen had been passed into them, arsenic acid was readily proved to be present in the residues, by the addition of nitrate of silver. Bromine acts in a similar manner. Iodine has no effect. Solutions of the chlorides of gold, platina, and mercury, of permanganate of potash, of sulphate of copper, and iodic acid, were successively used for receiving the arseniuretted hydrogen. The gas underwent decomposition in all of these solutions, but only to a partial extent. Among those above enumerated, the solution of chloride of mercury, as stated by Berzelius more than thirty years ago,¹ appeared to have the greatest power in arresting and fixing the arsenic. The results of these experiments were, that no liquids so completely oxidized

¹ 'Traité de Chimie,' 1829, tome ii, p. 437.

arseniuretted hydrogen, without loss, as nitric acid and a strong solution of nitrate of silver. When the current was properly managed, not a trace of the gas escaped.

Quantitative analysis.—If the quantity of arsenic present is moderately large, it may be determined in the first stage, viz., by adding to the distillate containing chloride of arsenic a sufficient quantity of a solution of chloride of gold, and warming the mixture. After some time the gold is entirely reduced and precipitated. Its weight will enable the operator to calculate the proportion of arsenic present.¹ If there is a ponderable quantity of arsenic present, the distillate, or an aliquot part of it, should be diluted, placed, with metallic zinc, in the apparatus described, and the gas produced, entirely transmitted into strong nitrico-nitrous acid. When all the arsenic has come over, the acid should be evaporated in a light balanced capsule on a sand-bath, and the weight of arsenic may be known by the increase. If converted to arseniate of silver, and the quantity is sufficient for collection on a filter, this precipitate may be dried and weighed. Every 100 parts of the arseniate of silver are equivalent to 21.38 parts of arsenious acid. In reference to imponderable quantities, the only method of estimating the quantity of arsenic is the comparing of the amount of metallic deposit obtained by heating the current of arseniuretted hydrogen with the amount obtained from a weighed quantity of arsenic, dissolved in water, and treated in a similar manner.

For determining the quantity in the tissues, a known weight,—one hundred grains of dry liver, may be distilled:—the chloride obtained converted entirely to hydride, and this, decomposed by passing the gas into nitric acid until the arsenic is exhausted. The residue left by evaporation will be arsenic acid, of which 100 parts correspond to 65.2 of arsenious acid.

Objections.—This process appears to be singularly free from the objections to which those of Marsh and Reinsch are exposed. In the first stage, if properly conducted, arsenic is separated from all metals excepting antimony and bismuth, and from all metalloids excepting sulphur, phosphorus, and that rare substance, selenium. Of all the metals known, fourteen produce volatile chlorides; but, with the exception of arsenic, antimony, and bismuth, these are deposited on cooling, in a

¹ See Will's, 'Guide de l'Analyse Chimique,' 1858, p. 66.

solid condition. Most of these are chlorides of the rarer metals, which are not likely to be met with in any analysis of a medico-legal nature. The chloride of arsenic is volatile, and is easily distilled with aqueous vapour: the chlorides of antimony and bismuth require a much higher temperature for volatilization; and unless the material is distilled to dryness and subsequently heated, they are not likely to be found in the acid distillate.¹

In the second stage, antimony comes over with hydrogen, like arsenic. The only other metals which combine with hydrogen to form a gas are potassium, tellurium, and zinc; and among the metalloids, sulphur, selenium, phosphorus, and carbon. When heat is applied to the current of gas, the only substance deposited in a form to be mistaken for arsenic is *antimony*. The other substances present no difficulty whatever. Their colour, and their other physical properties, as well as the absence of any crystalline sublimate on heating to about 400° the deposit obtained by heat, at once distinguishes them from arsenic. The deposit produced by heat from the hydrogen-compound of antimony is blacker than that procured from arsenic; and if air is not entirely excluded at the time of heating the tube, some oxide, of a greyish-white colour, is at the same time deposited. The antimonial deposit is known from that of arsenic by its requiring a high temperature for sublimation, and by its not producing octahedral crystals. It is simply converted to a white amorphous oxide, at a higher temperature than the arsenical deposit requires for its sublimation. If a sufficient quantity of oxide is obtained in the form of a sublimate, this may be dissolved in a solution of pure tartaric acid, and the antimony precipitated from this solution, as an orange-red sulphide, by a washed current of sulphuretted hydrogen gas. The crystalline sublimate from arsenic can be driven by heat to various parts of the tube; the amorphous deposit of antimony is fixed. Finally, these metals are entirely separated and distinguished from each other in the third stage. The antimoniuiretted hydrogen received into strong

¹ Ten grains of subnitrate of bismuth were distilled by a sand-bath with two drachms of pure hydrochloric acid. A small piece of polished copper boiled in the distillate, diluted, was only faintly whitened. Ten grains of protochloride of tin were distilled with two drachms of pure hydrochloric acid. The acid liquid produced no change on metallic copper by Reinsch's process.

nitric acid is converted into antimonious or antimonie acid, which is left as a white, non-deliquescent residue by evaporation of the acid. This residue is quite insoluble in water and alcohol; and thus any arsenic acid mixed with it may be separated from it, by digesting the residue in watery alcohol, and filtering the liquid. If tested by nitrate of silver, in the capsule in which it is collected, no red-coloured precipitate is produced; but on adding a drop of ammonia, black antimonide of silver is immediately formed. The passage of antimoniu-retted hydrogen into a solution of nitrate of silver causes the precipitation of the whole of the silver as a black antimonide. The filtrate precipitated by hydrochloric acid gives no precipitate with a current of sulphuretted hydrogen. By either of these methods, therefore, arsenic and antimony are discovered in traces, are known from each other, and can be separated from each other.

Arsenic acid and the alkaline arseniates, as well as the sulphide of arsenic, are not easily obtained in the form of chloride of arsenic by the distillation process. Some portion passes over as chloride of arsenic, but much remains unchanged in the retort. Arsenious acid and the arsenites, soluble and insoluble in water, are most readily obtained in the form of chloride. These compounds chiefly concern the medical jurist. To one case of poisoning by arsenic acid or the sulphide, there will be at least one hundred cases of poisoning by arsenious acid. Should it be required to distil arsenic acid or its compounds, it will be advisable to convert it to arsenious acid by a current of sulphurous acid, or by the addition of bisulphite of soda. Sulphide of arsenic may be similarly transformed, by being first treated with nitro-hydrochloric acid.

Applications of the process.—Including the analyses for arsenic in copper already referred to (p. 228), I have applied this process during the last year in probably not less than seventy instances. In cases in which negative results were obtained from the distillate, no arsenic was found by Reinsch's process, either in the distillate or in the acid residue in the receiver. The process presents this great advantage to the toxicologist; it may be safely adopted without interfering with the research for other poisons. With the exception of mere traces of antimony and bismuth, that pass by distillation, all other metals remain in the residue after distillation; and with respect

to these two metals, the greater proportion remains behind. Hence after separating arsenic, the residue may be examined for antimony, mercury, copper, lead, and other metallic poisons, by the ordinary processes. On the other hand, if the presence of any volatile poison, such as alcohol, prussic acid, ether, or chloroform, is suspected, a water-bath distillation, to separate any of these liquids, may be resorted to, before commencing the research for arsenic. A portion of the residue may in all cases be reserved for the research for organic alkaloids.

The subjoined experiments were purposely resorted to, in order to test the efficacy of the process.

1. *The stomach*.—The contents and part of the coats of the stomach of a person had been examined for arsenic by Reinsch's process, and no arsenic was found. The remainder of the stomach had been exposed for some months, and was in a dry state. A solution containing three eighths of a grain of arsenic was poured over the surface; in this state it remained exposed five months longer. One third of it was then cut up and distilled with two ounces of pure hydrochloric acid, in the manner already described (p. 241). The distillate was acid, and nearly colourless. It yielded arsenic readily by Reinsch's process, as well as metallic arsenic from arseniuretted hydrogen,—arsenious acid by the use of nitrate of silver, and arsenic acid by the use of nitric acid. The dry residue in the retort was tested by Reinsch's process. It contained no arsenic. In this experiment, the quantity of arsenic operated on in the substance of the stomach could not have exceeded one eighth part of a grain.

2. *The liver*.—Sixty grains of the dried liver of a person who died about five years since from the effects of arsenic, were broken up and distilled with hydrochloric acid. A slightly coloured, offensive liquid was obtained in the receiver, which yielded arsenic readily by the methods described, in all the forms in which arsenic admits of recognition. The residue in the retort contained no arsenic.

3. *A poisoned lozenge*.—This was an ordinary sugar-lozenge, poisoned with a grain of arsenic. It was distilled with hydrochloric acid. Arsenic was abundantly procured in the distillate, which was of a yellowish-brown colour, arising from the presence of some organic matter. This was not, however, in sufficient quantity to interfere with the subsequent stages of

the analysis. The sugar darkened considerably in the retort, and gave much froth. The process of distillation was found to be more troublesome with saccharine than with other kinds of organic matter. A trace of arsenic was detected in the residue in the retort, showing that in this instance, by one distillation, the arsenic had not been entirely separated. The quantity was, however, so small that it was not considered necessary to resort to a second distillation.

4. *Arsenical paper-hangings*.—About half a square inch of a green paper, coated with the aceto-arsenite of copper, gave, on distillation with hydrochloric acid, a clear acid distillate, from which arsenic was readily procured in its usual forms.

5. *River water, containing arsenic*.—This was probably as severe a test as could be selected for the process. Two samples of water, one of two gallons, and the other of one gallon, taken, at an interval of six months, from a pipe supplying an inn in a country town, were respectively evaporated to dryness. Each left a dirty, ochreous-looking deposit, weighing in the larger sample twenty grains, and in the smaller sample thirteen grains. The acid distillates of these residues were successively placed in the small tube-apparatus for generating hydrogen, described at p. 247; and a capillary tube was connected by a cork¹ with the chloride-of-calcium tube. Some lead paper was also introduced into the mouth of this tube, in order to stop the sulphur. The issuing gas, in each case, blackened paper wetted with the nitrate of silver. It had no effect on lead-paper. A full red heat was applied to the tube just before the spot at which it was drawn out. A well-marked deposit of metallic arsenic was obtained in the cool and contracted part of the glass tube. This was estimated by comparative experiments at about 1-250th part of a grain in a gallon of each water. The quantity was so small that no other test could be resorted to, excepting the process of Reinsch, which gave a clear arsenical deposit on a small piece of polished copper. The metallic deposit in the capillary tube had the appearance and entire volatility of arsenic.

¹ I have found in these researches, that when vulcanized rubber is made the medium of connection for the glass tubes, some sulphur is invariably carried over.

The amount of arsenic here found, represented about one grain in two hundred and fifty gallons of water.¹

6. *Sediment of a river.*—Two ounces of a sandy sediment, collected from the bed of a small stream in Derbyshire—above any position from which arsenic could find its way into it from any artificial source—were mixed with hydrochloric acid and distilled. The acid distillate was perfectly clear and colourless. It yielded a well-marked quantity of metallic arsenic, when tested in the tube-apparatus, as also by Reinsch's process. In another sample, procured from the same spot, which had been distilled by Mr. Dugald Campbell, arsenic was also found, with traces apparently of antimony.

7. *Thames water.*—Considering the above results as rather remarkable, and to a certain extent confirmatory of the opinion that arsenic is pretty widely distributed through soils in which pyrites or ochreous compounds are found, I examined the dry residue of a gallon of Thames water by the distillation process, and found therein, besides sulphur, a trace of a substance resembling metallic arsenic. It would require, probably, the residue of several gallons to determine the question distinctly.

¹ Samples of water taken, at or about the same dates, from the same pipé were examined by Dr. Miller and Dr. Lyon Playfair. The result was, that these gentlemen, acting independently, and employing entirely different methods of research, also found arsenic in this water. In their opinion, the arsenic proceeded from the refuse of certain chemical works on the stream; but as the dried mud of the stream yielded only four tenths of a grain to a pound, and arsenic was found in the mud of the stream above all Chemical works it was, in the opinion of Mr. Campbell and myself, an impurity which might be explained by reference to natural causes. The Wiesbaden water contains a larger proportion of arsenic per gallon; and there are no chemical works to account for its presence there.

In the 'Chemical News' for August 25, 1860, p. 127, Mr. Church has published the results of some experiments on the water of the river Whitbeck, in Cumberland. The water was alkaline, and when analyzed yielded distinct indications of the presence of arsenic. The arsenic existed as arsenite,—not as a mere trace, but in determinable quantity. In some seasons of the year, the proportion approaches a good fraction of a grain of arsenic (metallic) in a gallon of water. The locality from which the stream takes its origin is rich in minerals. Mr. Church found there arsenical cobalt, and from this the arsenic is probably derived. The arsenical water is habitually used for every purpose by the inhabitants of the village of Whitbeck, and with beneficial rather than injurious results. This appears to show clearly that river water may be arsenical wholly independently of chemical works on the banks.

7. *Mud or sediment from the Thames.*—Some of this mud was collected at low water, on the west side of London Bridge. It was taken partly from the surface, and from a few inches in depth. Two ounces of the mud in a dry state, the water (forming 34 per cent.) having been expelled in a water-bath, were distilled with two ounces of pure hydrochloric acid. One ounce of a clear and colourless acid liquid was obtained in the receiver. It was placed in the tube-apparatus with zinc, and the gas being previously dried, and deprived of any sulphur, was passed into a solution of nitrate of silver. After a short time, there was a dark metallic deposit of the usual black precipitate, indicative of the presence of arsenic; and on applying heat to the current, a deposit of metallic arsenic was procured, which was estimated at not less than the 1-2000th of a grain. I am informed that, during the last summer, no chemical liquids have been introduced into the river for the purpose of deodorizing it; hence, the presence of arsenic in the mud cannot be ascribed to the poisoning of the water by the use of arsenical chloride of iron. The arsenic must be derived either from factories on the banks of the river, or from the arsenic naturally diffused through soils containing oxide of iron.

In these instances, it may be remarked, the arsenic was in an insoluble form.¹

9. *Metals and metallic salts.*—The detection of arsenic in such metals as copper, iron, or lead, is effected by distillation

¹ It is now well known that a large number of mineral waters in France and Germany contain arsenic. In the 'Annuaire de Chimie' for 1849, p. 277, there is a list of forty mineral waters, including six of the well-known Vichy waters, which contain arsenic. Those of the Upper and Lower Rhine also contain this substance. (See 'Annuaire,' 1848, pp. 189 to 194.) The waters of the Baths of Alexis, on the Hartz, evidently derive the arsenic from arsenical pyrites in the soil. According to Dr. Hofmann, the Wiesbaden water, which is generally considered a wholesome water, contains one grain of white arsenic in a hundred and sixty-six gallons. ('Chemical News,' August 11, 1860, p. 101.) This is a larger proportion than that found in the water supplied to a country town above referred to (p. 253). The mud or ochreous sediment of these waters also contains it. ('Annuaire de Chimie,' 1848, pp. 189—194.) It is probable if the sediment of most of our rivers was examined, arsenic would be frequently found therein as a natural constituent. This method of analysis will be found convenient for detecting arsenic in waters. An acid salt of iron is always produced during the distillation, but, with ordinary care, this does not pass over with chloride of arsenic so as to affect the subsequent steps of the process.

with hydrochloric acid, after their conversion to chlorides. This method has been already fully described in reference to copper (p. 239). In July and August, 1859, I first employed it for the detection of arsenic in sulphate and insoluble oxychloride and arsenite of copper, as well as in chloride of tin, the sub-nitrate of bismuth, and grey powder. In ten grains of the sulphate of copper supplied from the shop of a medical practitioner arsenic was found. It was detected in some of the green incrustation derived from the action of chloride of sodium on metallic copper, showing that, in some forms of cupreous poisoning, arsenic is certainly present. Scheele's green, in all its varieties, whether on paper-hangings or in confectionery, yields arsenic by distillation in great abundance. Out of five samples of bismuth supplied by respectable druggists, arsenic was found in three; and out of as many samples of grey powder, arsenic was found, and that only doubtfully, in one.

I have lately employed this process on a large scale, in the examination of the viscera of three persons whose bodies were exhumed after from six to nine months' burial, and of the viscera of two persons recently deceased. The results were negative for arsenic. Antimony was found in four of the bodies; but no trace of this metal was procurable by distillation with hydrochloric acid. When large quantities of viscera are used, a capacious retort or flask must be employed. Arsenic, when present in large quantity, may be obtained by the distillation of viscera in their ordinary state with strong hydrochloric acid. I find, however, that it is much better to reduce the bulk and expel the water by drying the substance cut in slices, and by exposing them to a free current of air. The operator can then not only deal conveniently with more matter in one analysis, but he is more certain of obtaining the arsenic in the form of pure chloride in the distillate. The dried viscera, finely cut up, should be allowed to digest for a few hours without heat in the closed flask in which they are to be distilled. This breaks structure, and renders distillation easy. It will be observed in the application of this process, that it may be as necessary to redistil the distillate, if coloured, in separate organic matter; and at other times, the residue in the retort may require a second distillation with

strong hydrochloric acid. In all cases, the residue in the retort should be tested by Reinsch's process, in order to determine whether any arsenic is retained in it. By adding to one portion of the residue, chlorate of potash and a little hydrochloric acid, and boiling the mixture, the organic matter may be destroyed; any arsenic converted to arseniate of potash, and the clear filtered liquid tested by Marsh's process.

In the distillation of recent and undried viscera, most offensive products, including sulphur-compounds, are evolved. These are decomposed if the distillate is kept for a few days, and sulphur is deposited. If tested immediately with the hydrogen apparatus, sulphuretted hydrogen is evolved. This may be stopped by a salt of lead, in the manner already described at p. 247. If the hydrogen compounds of sulphur and arsenic pass over together, the application of a red heat leads to the production of an orange-yellow sulphide of arsenic at the end of the metallic deposit. Sulphur alone can never be mistaken for metallic arsenic. Its yellow colour, its property of readily melting, and the absence of any solid product as a result of the action of nitric acid,—are characters which will prevent any mistake on this ground.

Novelty of the process.—The reader will have perceived from the foregoing remarks, that the process here recommended has no pretensions to novelty. It consists simply in the association or arrangement of the well-known chemical properties of arsenic so as to render them more easily demonstrable than they have hitherto been. The processes of Marsh and Reinsch have been introduced in a form less objectionable than that in which they were left by their discoverers.

The chloride of arsenic has been long known as a volatile compound. Berzelius, and chemical writers subsequently to him, describe its properties, and refer chiefly to one method of preparing it; namely, by distilling at a high temperature a mixture of arsenious acid and corrosive sublimate. In 1841, Dupasquier found that arsenious acid was very soluble in hydrochloric acid, and he considered the solution to contain chloride of arsenic. When submitted to distillation, he found the distilled product to be arseniferous.¹ Dr. Pereira states

¹ Quoted by Pereira from 'Journal de Pharmacie,' tome xxvii, p. 717, 1841. Pereira, Elements of Materia Medica, &c., by Taylor and Rees, 1854, p. 720.

that on repeating the experiment, he found the quantity of arsenic which distilled over was very small, and that the residual liquor in the retort deposited octahedral crystals of arsenious acid.

In employing Reinsch's process in various analyses for arsenic in the dead body, during the years 1846-7, I found that there was a loss of arsenic; and the following passage in reference to this subject occurs in the first edition of my work 'On Poisons:' "The boiling of the tissues in muriatic acid for the extraction of arsenic should take place in a *close vessel*; such as an alembic or a capacious retort with a receiver attached to it. There is, beyond all doubt, a loss of arsenic when this precaution is not adopted. In May 1847, the following experiment was performed in order to determine this point. Four grains of arsenious acid were dissolved in five ounces of distilled water, to which five drachms of concentrated muriatic acid had been previously added. The vessel was so large as to prevent the possibility of any liquid being carried over *mechanically*. The boiling was continued for two hours, when nearly one half of the liquid had been collected in the receiver. This was found to contain arsenic on applying Reinsch's process."¹

I have at intervals since this time, continued the practice of boiling the tissues in a retort and analysing the distillate, whenever a suspicion existed that arsenic was present, but in very small quantity; and when Reinsch's process did not at once indicate the presence of the poison.

The fact, therefore, that arsenic could be procured from the tissues by distillation with hydrochloric acid, has been known and acted on for the last fourteen years. The facilities presented by Reinsch's process, had rendered it unnecessary to resort to distillation in most cases, as the presence of organic matter did not interfere with its operation.

In 1849-50 I find, from notes in my possession, that my friend and colleague, the late Mr. Arthur Aikin, laid before the classes of Guy's Hospital, and demonstrated the method of procuring chloride of arsenic by the use of salt and sulphuric acid. The note is to the following effect:

"If one part, by weight, of arsenious acid, three parts of

¹ 'On Poisons in relation to Medical Jurisprudence and Medicine,' 1st edition, 1848, p. 363.

common salt and four parts of strong sulphuric acid, are mixed and distilled, there comes over a thick, oily liquid, formerly called butter or oil of arsenic, which is hydrated terchloride ($\text{As Cl}_3 + 3\text{HO}$).” MSS. lectures. In 1851-2, Dr. Schneider proposed a mixture of salt and sulphuric acid for procuring arsenic from organic matter, and it succeeded more perfectly than he had anticipated, considering that the anhydrous chloride of arsenic does not boil under 270° .¹

Schneider advises that the salt and acid should be accurately tested before use, so as to ascertain that they are free from arsenic. He gives a number of minute precautions, and a form of apparatus, for an account of which I must refer the reader to his work. The common salt should always be in large excess, in order to prevent the production of sulphurous acid by a reaction towards the close of the distillation, between the organic matter and sulphuric acid. He found that when arsenious acid was dissolved in a large excess of hydrochloric acid and distilled, the whole of the arsenic went over as the chloride mixed with the vapour of the acid; not a trace of arsenic remained in the retort. Thus he found it impossible to purify by distillation hydrochloric acid, rendered impure by arsenic, or even liquids of which hydrochloric acid was a large constituent. He pointed out the fact, that in most researches for arsenic, the volatile chloride may be produced; and if in small quantity, the poison may be entirely lost, and a negative result obtained, when, with greater care, the presence of the poison would have been detected.²

Having given to this method a fair trial, I find it far inferior to that which I have above recommended. In mixing the salt and acid there is great frothing, with a large escape of vapour. In some cases in which pure hydrochloric acid operates effectually, this process will not detect arsenic. This occurs in reference to arsenic in metallic copper, and in certain metallic salts. Schneider states, that the sulphide of arsenic is readily converted to the chloride by this process, provided a larger quantity of salt and acid is used, and the distillation

¹ ‘Die Gerichtliche Chemie für Gerichtsärzte und Juristen,’ bearbeitet von Dr. F. C. Schneider, Docenten der Chemie an der Wiener Universität. Vienna, 1852, pp. 193, 206.

² Op. cit., p. 194.

maintained for a longer time. The further steps of the process, as described by Schneider, are as follows: The distillate containing chloride of arsenic is placed in a Marsh's tube; the resulting gas is decomposed by heat, so as to produce an arsenical mirror, and another portion is allowed to pass into a solution of nitrate of silver, in order to procure a solution of arsenious acid, to which the usual tests may be applied.

As a result of some recent investigations, it has been found that an excess of sulphuric acid prevents the formation of chloride of arsenic. In fact, the chloride, when treated with concentrated sulphuric acid, is decomposed into hydrochloric and arsenious acids, the latter of which remains behind in the retort.¹ Hence, unless care be taken respecting the proportions used, the object of the process will be entirely defeated. On one point the results of my experiments are quite in accordance with those of Schneider. If the distillation is carefully and properly conducted, and carried on for a sufficient time, the whole of the arsenic contained in the organic matter will be transferred to the distillate.²

Schneider's process has been largely employed in Germany, but it has been little used in this country. A description of it was published in the 'Pharmaceutical Journal' for July, 1853, p. 38. About this date Dr. Clark, of Aberdeen, took up the subject, and, as I am informed, employed the process successfully in some medico-legal investigations for arsenic. In the fifth edition of my 'Medical Jurisprudence,' 1854, I briefly referred to it, stating that the arsenic contained in organic liquids or solids might be procured as chloride, in a receiver, by distilling the organic matter with a mixture of common salt and sulphuric acid; and, further, that the chloride of arsenic thus obtained in a pure state might be subsequently analysed by any of the usual processes.

According to Dr. Christison, the process of extracting arsenic by distilling the viscera with hydrochloric acid, was employed by Dr. Penny, of Glasgow, in 1852. In the case of Madeleine Smith (1857), both Dr. Christison and Dr. Penny obtained arsenic by the distillation of the viscera of the deceased L'Angelier with hydrochloric acid—the one from the liver, and

¹ 'Archiv. der Pharm.,' and 'Chemical News,' June 23, 1860, p. 24.

² Op. cit., p. 207.

the other from the fluid contents of the stomach. Dr. Christison's mode of operating is thus described in his evidence: "About four ounces of the liver were subjected to a modification, proposed in 1852 by Dr. Penny, of the process of Reinsch for detecting arsenic in such matter. The liver having been cut into small pieces, and boiled in hydrochloric acid and distilled water, in a glass flask, to which a distilling apparatus of glass was connected, the whole texture was gradually reduced to a fine pulp, and a distilled liquor was obtained which was collected in divided portions. These liquors were colourless and nearly clear. The first two portions obtained did not contain any arsenic;¹ the third gave faint traces of it; the fifth and sixth portions, when separately subjected to the action of copper-gauze, gave characteristically the usual dark grey incrustation, and this again was driven off as usual by heat in a small glass tube, and yielded in each case a white, sparkling ring of crystals, which were regular octaedres, or forms derived from the octaedre. The liver, therefore, contained arsenic."² Dr. Penny states, "A fourth portion of the prepared fluid (contents of the stomach) being properly acidified with hydrochloric acid, was distilled and the distillate subjected to Fleitman's process. For this purpose it was boiled with zinc, and a strong solution of caustic potash. Arseniuretted hydrogen was disengaged, and was recognised by its odour as well as by its characteristic action on nitrate of silver."³

It appears that, in the above cases, the acid employed in the distillation was used in a diluted state, as it was employed by myself in 1846-7. This was, no doubt, the cause of the arsenic not coming over entirely. Dr. Christison simply applied Reinsch's process to the distillate; and Dr. Penny, although he might have obtained arseniuretted hydrogen by the use of zinc alone, added a strong solution of potash. The

¹ No chloride was produced until some water had been expelled.

² Irvine's 'Report of the Trial of Madeleine Smith,' 1857, p. 61. It would thus appear that the use of Reinsch's process with copper gauze untested in its substance for arsenic, was employed by this excellent chemist and toxicologist up to the summer of 1857 for the detection of arsenic in a liver, in a case of alleged murder by poison, and with perfect safety as to the results.

³ *Op. cit.*, p. 54.

only tests to which the gas thus procured was submitted, were the peculiar odour and the action of nitrate of silver.

In the 'Guy's Hospital Reports' for 1855,¹ Dr. Odling has published the account of an experiment which, at the suggestion of the late Mr. Scanlan, he performed on the stomach of a dog. He distilled it to dryness with hydrochloric acid. Arsenic was very abundantly detected in the distillate, and the residuum was not by any means free from the poison. Altogether, the process did not present any advantages to compensate for the increased trouble attending it. Subsequent experience has, however, satisfied him that he had here undervalued this method of separating arsenic.

This, I believe, comprises all that is recorded in English medical literature, or that has been done by English chemists in reference to the method of separating arsenic by hydrochloric acid, up to the summer of 1859. It was at this time that the objections taken to Reinsch's process induced me to revise the facts already known regarding the action of hydrochloric acid on arsenic, and the conditions under which the acid might be used for the separation of this poison from organic matter. During the last twelve months I have made many experiments on this subject, the results of which are here given. In addition to the other well-known properties of arseniuretted hydrogen, for which science is indebted to the researches of Gay Lussac and Soubeiran, I have found that the use of strong nitric acid for oxidizing the gas is a useful addition to this branch of medico-legal research, a fact which appears to have been hitherto overlooked.

PROCESS FOR ANTIMONY.

I have little to say on this subject; for nearly all that can be said is comprised in the foregoing remarks.

For the detection in, and the separation of antimony from, the *tissues*, the best plan, according to my experiments, is that which was originally suggested by Reinsch, in 1841. The antimonial compounds, when distilled with hydrochloric acid,

¹ Third Series, vol. i., p. 293, 1855. In the last volume of these 'Reports' for October, 1859, the experiment is again referred to at pp. 370 and 371, but by a typographical error the year is set down in both references as 1851, instead of 1855.

do not readily pass over into the receiver. They are much more fixed than those of arsenic.

In the examination of the tissues of persons poisoned by antimony, I have not been able to procure by distillation with hydrochloric acid, any trace of the metal in the distillate, although antimony was readily found by Reinsch's process in the residue in the retort. If this fact should be corroborated by future inquirers, the distillation-process will furnish a ready method of separating absorbed arsenic from absorbed antimony.

In reference to the distillation of the saline compounds of antimony, I have found that, contrary to what might be expected, the metal passes over more readily into the distillate when the acid is mixed with water, than when it is concentrated, but even in this case the quantity thus obtained by distillation is very small.

EXPERIMENT 1.—One grain of tartar-emetic was dissolved in two ounces of water; three drachms of strong hydrochloric acid were added. The mixture was distilled to dryness. One third of the acid distillate gave no indication of antimony by passing into it a current of sulphuretted hydrogen gas. The other two thirds gave violet deposits on copper, coating about one quarter of a square inch of foil on both sides. It was ascertained that the greater part of the antimony still remained in the dry residue in the retort, the heat not having been sufficient to carry over the chloride.

EXPERIMENT 2.—One grain of tartar-emetic was dissolved in two drachms of pure and concentrated hydrochloric acid, and distilled to dryness. The acid distillate yielded a mere trace of antimony, by Reinsch's process—not exceeding the 1.4000th part of a grain. The residue in the retort gave an abundant white precipitate of oxychloride of antimony on the addition of water. This was immediately dissolved by a solution of tartaric acid, and the antimony subsequently precipitated, as an orange red sulphide, by passing into it a current of sulphuretted hydrogen gas. It is worthy of remark that *arsenic* passes over most readily with the strong acid; hence, if viscera are suspected to contain deposited arsenic and antimony, the arsenic may be obtained by distillation, and the antimony

separated from the organic matter in the residue, by Reinsch's process. The method of proceeding for antimony is, therefore, as follows:

1. Boil the viscera, in a finely divided state, in one part of pure hydrochloric acid, and from four to six parts of water. Boil in a flask or retort, and condense by a funnel the acid vapour as it issues. Introduce slips of polished copper-foil (free from antimony). Continue the boiling for at least two hours before concluding on a negative result. In certain cases it may be necessary to employ from twelve to sixteen ounces of organic matter in one operation.¹

2. Wash in water the pieces of copper when coated, and observe the violet or steel grey film, according to the thickness of the metallic deposit (see page 213).

3. Boil as many of the coated pieces of copper as can be collected, in a solution of pure potash, in a test tube, occasionally exposing the coated surfaces to the air. The antimony is oxidized and dissolved off by the potash.

4. Filter the potash-solution; acidulate with pure hydrochloric acid, and pass into the liquid a current of sulphuretted hydrogen gas. An orange-red sulphide of antimony is precipitated.

5. Filter the liquid and wash the precipitate. Add a few drops of solution of ammonia, and note its insolubility in this liquid. Any sulphide of arsenic is dissolved, carried through the filter, and may be found in the filtrate.

6. Again wash the sulphide, and then dissolve the precipitate in pure hydrochloric acid, taking care to boil the liquid, in order to set free all the sulphur as sulphuretted hydrogen.

mounted a tube-apparatus for hydrogen, as arsenic (see page 247), pour the solution of the funnel into the tube.

gas evolved at the capillary end of the tube by rate of silver, and if the solution is blackened, gas by applying a red heat to the tube. e with the metallic deposit, and gently heat it octahedral crystals are obtained; or whether, at

recent cases of antimonial poisoning at Liverpool, Dr. Edwards used thirty ounces of the liver, and to boil the liquid for several hours, and a clear antimonial deposit on the copper foil.

a higher temperature, it simply forms a white amorphous oxide.

The antimoniuretted hydrogen may be in sufficient quantity to be collected in strong nitric acid. In this case the nitric acid, after saturation, should be evaporated and tested, as already described (see page 251).

Instead of decomposing the chloride by zinc, the operator may dilute it until the water forms one tenth part, and plunge into it a slip of pure tin, free from arsenic or antimony. If, as Millon and Laveran have shown, the liquid contains antimony, even in minute traces, the surface of the tin will be sooner or later coated with a fine, black, pulverulent deposit of metallic antimony. Arsenic is not thus deposited, or there is only a slight discoloration of the tin, after some days. In the absence of antimony, the surface of the tin, after several days, presents merely a crystalline appearance.

The process above described is sufficiently delicate for all practical purposes. As a proof of this, I may mention that it enabled Dr. Miller, Dr. Edwards, of Liverpool, and myself, to procure good evidence of antimony in a liver containing not more than 1-160th of a grain in two ounces of its substance. We also employed the process successfully for the detection of free and absorbed antimony, when existing in very small quantity in sixteen separate analyses of the viscera. Three of the bodies, from which the viscera were taken, had been buried for a period of from six to nine months.

ADDITIONAL NOTES
ON
DIABETIC CATARACT.

BY JOHN F. FRANCE.

WHEN drawing attention, in the early part of last year, through the medium of the 'Ophthalmic Hospital Reports,'¹ to the above-named affection, I was unaware of any previous reference to it, except a few words penned by Dr. Mackenzie, of Glasgow.² It subsequently appeared that Dr. Duncan, of Edinburgh, had also incidentally remarked, "In diabetic patients there is a tendency to cataract."³ But, with the exception of these passing allusions, the existence of any specific connection between cataract and diabetes, had, I believe, until the date of my paper, been entirely overlooked. Since that time, several additional examples have, by the kindness of different observers, been communicated to me; and the occurrence of others has been notified more or less directly. I am therefore, as the subject is somewhat novel, and the information upon it scattered, induced to make the following concise *résumé* of the facts which have been elicited hitherto, as far as I have been fortunate enough to meet with them; observing, at the same time, that other isolated instances may in all probability have been published besides these, and, being isolated, have escaped attention.

Dr. M'Kenzie records his experience in the following words:

¹ January, 1859.

² 'Diseases of the Eye,' 1854.

³ Footnote in Translation of Braun on 'Uræmic Convulsions.'

“I have in three instances seen lenticular cataract attack women of from eighteen to twenty-five, labouring under diabetes mellitus. I have also met with the same complication in males at a later period of life.” Hence it is apparent that this eminent surgeon has encountered at least 5 *cases*.

Dr. Duncan’s remark, he has informed me, was grounded on personal observation; for, by a curious coincidence, he had met with diabetes associated with cataract in 3 *cases* simultaneously.

My own contribution already referred to, comprised a narration of 4 *cases*.

Mr. H. Walton has given¹ an interesting account of 1 *case*.

Mr. Wilde, of Dublin, though unable to recognise any connection between diabetes and cataract, has seen the complication² in at least 2 *cases*. [His words are: “I have seen patients labouring under diabetes, where cataract also existed;” and again, “certainly, cataract operations in diabetic cases are by no means favorable”—language which implies a degree of familiarity with such cases.]

Mr. Veasey, of Woburn, kindly enabled me to quote in detail³ from his practice, 1 *case*.

Dr. John Sloane, of Leicester, has obligingly directed my attention to his record⁴ of 1 *case*. The patient, a young woman, had cataract form in both eyes in the course of diabetes, of which she ultimately died. The character of the cataracts was not especially noted; no operation was performed.

Dr. W. Newman, of Fulbeck, Grantham, has most kindly communicated some particulars of 2 *cases*, “which,” he observes in his letter to me, “so far as my brief notes go, corroborate your description of the affection.”

“Thomas S—, æt. 17, admitted (into the Salop Infirmary), April 14, 1855, discharged incurable, June 2d; had had diabetes nearly two years, passing from twelve to sixteen pints of urine per diem. Cataract in both eyes far advanced;

¹ ‘Med. Times and Gazette,’ Nov. 12, 1859.

² Ibid., Dec. 3, 1859.

³ Ibid., Dec. 17, 1859.

⁴ In the ‘British Medical Journal’ for 1858, p. 425.

sight failing six months; almost complete blindness for last three months."

"Margaret J—, æt. 34, admitted June 16, 1855; diabetes twelve months, probably eighteen months; weakness of left eye five months, now quite blind; lens quite opaque; right eye cataractous, but not so far advanced.

"No operation was attempted in either instance; and I speak from memory when I say, that in both cases the cataracts were believed, from bulging, &c., to be soft."

Mr. Barton, of Dublin, has also been good enough to furnish me with a notice of 1 case.

"John R—, æt. 43, was admitted into the Adelaide Hospital in December, 1858, under the care of Dr. Duncan, for diabetes. Soon after his admission, Dr. Duncan requested me to examine his eyes. Upon doing so, I found the lens of the right eye perfectly opaque, while that of the left was partially so. The patient could not discern anything with the right; and with the left eye, when the pupil was well dilated, only large and distinct objects. The diabetes was far advanced, and the results of operation in such cases having been found so unfavorable, the idea was not entertained in this case. The patient left the hospital after remaining under my observation for two or three weeks, and I heard of his death in April or May."

At the time of writing, a fresh and very characteristic example has been admitted into the clinical ward of Guy's, which is quoted below. This case, added to those just enumerated, raises the total which I am enabled to cite to 21—a number no doubt very far short of what extended inquiry might elicit; but still, I think, sufficient to prove the reality of the ophthalmic affection which I have termed Diabetic cataract, and suggestive also of its comparatively frequent development in the course of the parent disease; for all these examples rest on the authority of living English authors.

The history of the case now in Guy's (from the notes of Mr. Minns) is as follows:

Emeline D —, æt. 34, a single woman residing in Chatham, was admitted under the care of Dr. Pavy, July 18th, 1860. She is a pale, emaciated, prematurely aged person; but states

that her health, previously to this attack, was always good. She ceased menstruating two years since, and immediately after noticed an increase in the quantity of her urine. She has passed as much as six quarts during twenty-four hours; hunger and extreme thirst, with general exhaustion, are the predominant symptoms; she sleeps soundly, and is not troubled with cough or headache. About five months since she first noticed impairment of vision. This symptom came on gradually, affected both eyes equally, and was daily getting worse until within the last two months, during which time it has remained stationary. At present she is able to walk about the ward without assistance, and can tell large objects; but cannot see sufficiently to define their outlines, nor for the purpose of reading. There is no pain in the eyes, which appear in all respects healthy; but that there exist symmetrical, opalescent, lenticular cataracts (with superficial striæ) of unusual bulk. They are indeed so large, as to press the iris forward into close proximity with the cornea, leaving but a shallow interspace for the aqueous humour. The pupillary movements are sluggish, apparently from this mechanical impediment; since, on every contraction, the curtains are drawn laboriously over a projecting convex surface.

Under the treatment adopted by Dr. Pavy, the urinary complaint had greatly improved by the 10th of August. She had been ordered on admission *Tinct. Opii mxx ex Jul. Ammon. ter die*; and the diet had consisted of greens, gluten-bread, meat $\bar{3}$ xij, sherry $\bar{3}$ iv, daily. While in the clinical ward she passed the following quantities of water in twenty-four hours:

July 19th.—4 quarts, of specific gravity 1040, saccharine.

„ 20th.—6	„	„	„
„ 21st.—4	„	„	„
„ 22d.—3	„	„	„
„ 23d.—3	„	„	„
„ 24th.—2	„	1045	„
„ 25th.—3	„	„	„
„ 27th.—3 pints	„	„	„
„ 31st.—2	„	„	„

Aug. 4th.—2 pints only; but equally saccharine, as at first. She was transferred to the ophthalmic wards on the 12th

of August, where she continued the same constitutional treatment as before. Mr. France, considering the degree of useful vision still retained, and the risks attending an operation in her exhausted condition, recommended merely palliative treatment locally, which was also most congenial to the patient's inclination. The use of atropine was therefore prescribed, and she was shortly replaced under the physician's care.

Perhaps I might add to the above catalogue a case mentioned in the current number of the '*Ophthalmic Hospital Reports*,'¹ in which sugar in the urine coexisted with, or had preceded, cataract. The case, however, is given rather loosely; and there is room for doubt whether it was really one of the kind under consideration, or merely an example of the casual coincidence of the two affections.² From the published account, it is uncertain whether the elimination of sugar by the kidney continued, or had ceased, at the time of observation; whether both eyes, or one only, were involved, &c.; but the lens was opaque in various strata, and was soft, the patient's age being forty-four. Keratonyxis, and afterwards linear extraction, were performed on the left side, and "the eye recovered well from the operation."

Into the etiology of this class of cases, I refrain from entering further; but cannot, in connexion with that point, forbear alluding to the very remarkable facts lately brought to light by the experiments of Dr. Weir Mitchell. They are published in the '*American Journal of the Medical Sciences* for January, 1860;' and are corroborated by those of Dr. Richardson, still more recently related to the Medical Society of London, and partly printed in Dr. Brown-Séquard's '*Journal de Physiologie*' for July.³ These investigations seem to have a direct bearing upon the subject before us; for they show conclusively, that in several of the lower animals the abnormal introduction of sugar into the system (whether by immersion of the body in syrup for a sufficient time for the osmotic process to take place freely, or by injection beneath

¹ No. 11, p. 349.

² I wrote to the narrator, requesting the communication of any further particulars in his possession, but have not been favoured with any reply.

³ "The Synthesis of Cataract."

the integument) is almost certainly followed by the development of lenticular cataract. The analogy would appear close between the artificial production of opacity of the crystalline in this mode, and its natural formation in the course of diabetes mellitus.

But I leave the elucidation of the theoretical question to others, and will merely in conclusion repeat the description I originally gave of the characters displayed by Diabetic cataract; a description, the fidelity of which has been confirmed by independent observers, and with which the last case at Guy's closely corresponds. "The cataracts have in every example been symmetrically developed on both sides; the lenses have increased remarkably in their antero-posterior diameter, so as to encroach upon the depth of the anterior chamber, and even to interfere mechanically with the free play of the iris. The opacity has attacked portions of several strata of the crystalline at once, leaving intermediate spaces for a while transparent. The colour and bulk of the cataracts have invariably indicated their soft consistence, which was proved by operation in two persons, though respectively of 'middle,' and of forty-eight years of age. Lastly, the ocular affection has only arisen after considerable duration of the renal malady (a circumstance which may tend in some degree to account for the comparative rarity of their union); and there has, in no case, been reason to suspect further disease of the eye-ball."

REMARKS ON TWO CASES
OF
EXTRA-UTERINE FŒTATION.

BY J. BRAXTON HICKS, M.D. LOND., F.L.S.

THE following cases, one of tubal, the other synthetical fœtation, present some points of pathological and physiological interest; and having, through the kindness of the gentlemen mentioned below, come into our possession immediately after removal from the bodies, a much greater accuracy is thereby obtained with regard to the microscopical detail, than is possible after immersion in spirit. The delicate elements (as, for instance, of decidua) become so altered, as to render the results after immersion doubtful. Therefore, in all cases involving the use of the microscope, it is much better to forego the temptation of an investigation, than to pursue a course which will probably lead to inaccuracies.

We make these remarks because it is (at any rate to some) a vexata questio, whether the decidua-like membrane, found in nearly every instance lining the uterus in these abnormal conceptions, is really the decidua; and whether the decidua-like membrane, surrounding the ovum in its new cell, in some cases is a true decidua, and if so, a production of the ovum. These points, it seems to us, can undergo solution readily by careful microscopical investigation, comparing them at the same time with the structures upon which there is no dispute. Having, in the following cases, observed these precautions, we hope the inferences drawn from the examinations will help to a solution of the difficulty.

The first case, which is one of tubal fœtation, occurred in the practice of George Roper, Esq., of Shoreditch, whose report of the case is as follows :

“E. S—, æt. 33, was suddenly seized with severe pain in the lower part of the abdomen, on the 8th of April, 1860. She retired to her bedroom, threw herself on the bed, and vomited slightly. The pain soon became so agonising that she was speedily collapsed, and appeared in a dying state. She lay on her right side, partially inclining on abdomen, the thighs forcibly flexed, and when removed from this position instantly returned to it, and she could not be persuaded to lie in any other attitude. Her countenance was expressive of great suffering, and very pallid. Death ensued ten hours after the commencement of the pain.

“It appeared that she had been married about seven months. On the 1st January, she aborted at the end of the second month of her first pregnancy. The catamenia afterwards returned at the usual periods. She menstruated on the 26th February, and five following days. On the 18th March there was a slight sanguineous discharge—a mere stain. The day of her fatal attack being about the time for menstruating (were she not pregnant), she at first attributed the pain to the approach of that function. She had not been well for twelve months, having had that time since a whitlow, with abscess of axillary and cervical glands.

“She was well formed, and of fair complexion.

“A post-mortem examination was made twenty hours after death. The peritoneal cavity was found to contain four or five pounds of blood, which had escaped from a rupture of the Fallopian tube, the consequence of tubal pregnancy. After a minute search, the embryo was found amongst the effused blood in the middle of a large clot. The uterus and appendages were removed for examination.”

On *examination of the parts*, we found in the left Fallopian tube a swelling, of oval shape, rather nearer the uterine than the fimbriated extremity, tapering at each end, more so towards the fimbriæ, about an inch and a half long, rather less in breadth ; a rent in the upper and uterine end of the enlargement, from which a fœtus, not an inch long, had escaped, the

cavity which had contained it being filled with a clot of blood. On extending the opening, it was found that the interior of the swelling had been filled by the ovum, while the tapering ends were produced by the thickening of the wall of the tube, most so at the fimbriated end, to which part the placenta was principally attached, which in the collapsed condition occupied nearly half.

The development of the walls of the tube was found, on microscopical examination, to be produced by the active growth and enlargement of the cells of the wall-tissue, on the same plan as do the walls of the uterus under the stimulus of normal pregnancy, only that the outer layers contained bands of connective tissue formed from and mixed with ordinary uterine tissue. The inner surface of this cavity was covered with the ciliated, columnar epithelium (see Plate, fig. 1, *a*) proper to the mucous membrane of the Fallopian tube (and which it originally lined), and upon this surface the terminal tufts of the villi spread out (see Plate, fig. 1, *b, b*), the epithelium remaining on the parts not occupied by them. These terminations of the villi did not enter the substance of the tube-wall, which was apparently too solid and dense, but seemed merely adherent to it, a very minute portion of plastic matter seeming to assist at the points of contact. The coats of the villi were single, as far as could be detected, so that the placenta was purely ovular. That there was no maternal structure entering into the composition of the placenta could be further proved by close examination. The maternal vessels ramified beneath the epithelium-covered surface (see Plate, fig. 1, *c*) where they could be seen in some places only slightly raised above the level. These capillaries were evidently enlarged and numerous, but not so much as the uterine decidual membrane.

The uterus was enlarged to about three times its virgin size, its walls being proportionately thickened. The mucous membrane was in a pulpy state, extending throughout the whole internal surface. It was about one third the thickness of the uterine walls, presenting the appearance of decidua, though it was not so easily separated from the uterus as in the ordinary form, nor did there appear to be present the cavities known as "Montgomery cups;" still the line of separation was tolerably distinct. The surface of this decidua was very highly injected,

being covered by a network of capillaries. I have shown a section of a portion at fig. 2. The part of this membrane near the cervix was much congested, dark, and it appeared as if some blood had flowed about the time of death.

The microscope showed most distinctly that the other elements of this decidual membrane were precisely similar to those observed in the decidua formed in normal pregnancy. I have therefore considered it not necessary to figure them.

The ovaries, with corpus luteum in left one, were as in ordinary pregnancy.

The other case is one of more rarity, and exhibits the peculiar features of interstitial development very decidedly. It occurred in the practice of Mr. Blenkarne, of Dowgate Hill, who kindly furnished me with the specimen.

The position of the foetus, and the condition in which the uterus existed at the time of death, is shown in the accompanying drawing (see Plate). The following is the description of the dissection :

Uterus enlarged to six inches long, and three and a half to four inches diameter at the widest part. A ragged rupture appeared on the fundus, rather towards the left side, from which the blood had poured ; the parts around the rent were highly congested.

A section of the uterine walls showed their thickness had increased to about an inch and one eighth at widest part ; numerous and large venous sinuses being noticeable, especially towards the fundus.

A cavity, about three inches diameter (when collapsed), was situated in the substance of the wall of the fundus adjoining the left Fallopian tube ; this cavity had distended the walls externally so as to be apparent there, and had also encroached on the cavity of the uterus on left side of fundus. The walls of the cavity all round were easily seen to be formed of the uterine tissue ; and even at the thinnest part, where the peritoneum had given way, large bundles of muscular fibres could be recognised firmly attached to it. The wall separating it from the decidual cavity was very freely supplied by sinuses. The thickness of this part was about one sixth of an inch when

empty, but when supplied with blood it must have been much thicker.

A distinct decidual membrane lined the whole interior of the uterus; that on the projection caused by the cavity simulated somewhat the decidua reflexa. The microscopical characters of this decidual membrane precisely resembled the case above described, and could in no part of its elements be distinguished from true decidua. The cavity contained a foetus of apparently the size of the third month of normal pregnancy, with the appendages of the ovum as usual; the placenta was fully formed, and situated at the upper part of the cavity, as shown at (*a*) in the Plate. The only part *not to be found* as in intra-uterine pregnancy was a deciduous membrane, external to the chorion or placenta; of it there was not the slightest trace. The villi, as in the former instance, possessed only a single coat, and spread over, *but did not enter*, the uterine tissue to which they were affixed (see Plate, figs. 3 and 4, *a*). No membrane at that part was to be detected. Beneath the inner surface, immediately in contact with the villi, the uterine vessels spread themselves out, flattened, and so numerous that the whole substratum must have been almost as one blood-vessel, only the delicate membrane of the vessels separating the maternal blood from the villi where they were in contact (Plate, figs. 3, *b*, 4, *b*). The left ovary showed a very well developed corpus luteum, whose cavity had begun to diminish.

This case is instructive, and has some bearing on a practical point, in consequence of the nearly equal thickness of the walls of the cavity at the point of rupture, and at the part projecting into uterus. Had the rupture taken place internally, would it not, in all probability, have been mistaken for an ordinary abortion? and had recovery then taken place, the true condition would have never been detected. It is more than possible that interstitial foetation may occur oftener than is supposed.

In reviewing the above facts, we think we are justified in concluding—

1st. That the decidua-like membrane found in the uterus was a true decidua in the usual sense of the term. That is to say, a softening, and, at the same time, thickening of the inner

surface of the uterus, be that true mucous membrane or not, which change is produced by the active growth of the cells of that layer, the network of capillaries remaining still on the inner surface, being enabled to do so by the stretching out or uncoiling of the blood-vessels supplying them. It is through the meshes of the network, in ordinary pregnancy, that the villi push their points, till, by their enlargement, as well as that of the decidual vessels, the whole space is filled up, producing an intimate blending of the two systems.

None of these properties were absent in either of the above cases, and, without doubt, they would have fulfilled their proper function had it been called into requisition.

Whatever the nature of that stimulus may be which causes the development of the membrane, we might expect to find its effects less noticeable in deviations from ordinary conditions, and not also unreasonably suppose that the further from the uterus conception took place, the less would its effects be marked in the uterus itself; and this holds good in these cases. That the decidua in natural pregnancy is of *uterine* origin no one, I think, will deny. If this be so, we think it unphilosophical to assign an ovular origin to a membrane which is sometimes found external to the chorion in extra-uterine foetation. From the nature of the thing, a *decidua* must be of *maternal* origin, and if a structure should be found resembling it, it must be maternal, or not decidual at all. It is well known, that at the placental insertion the decidua, as a membrane, passes from the sight, being amalgamated with the placenta, in which case each placental villus has two coats—one ovular, the other decidual or maternal. In the above cases, at least, there was, as before mentioned, no trace of a decidua, or anything like it in function or appearance, on the terminations of the villi, which were only of one coat; consequently there was no decidua.

But suppose there had been a true decidua, what would it have proved? Would it any the more clearly have proved that its origin was ovular. As we take it, it would simply have proved that the lining of the Fallopian tube and the tissue of the uterine wall had undergone a similar change to that of the lining of the uterus, not that the membrane was in any way of necessity derived from the ovum.

But it may be argued that there *is* a membrane between the cavity and chorion, at least in some cases. We admit that there is a delicate, fragile layer in that position, in some specimens preserved in spirit, and which might have existed before immersion. We have carefully examined these, and have no doubt but that it is a layer of plastic lymph or fibrin, which has been deposited there, and sometimes in the membranes, the result of irritation not long prior to expulsion, the consequence of the death of the fœtus. There is no appearance like that of decidua; a mere fibrillation of fibrin, become rather dense by the spirit, but able to be torn in any direction.

We think it will be conceded, that in the above cases the interchange of elements was carried on by an endosmotic action, which took place between the two systems, by the simple apposition of vessels as above described; and therefore we must conclude, that a decidual membrane is not absolutely necessary to the foetal life. We cannot doubt but that the decidual membrane has an important use in the arrangement, perfect for its purpose, but it is not hence to be argued that it cannot be dispensed with in some instances, and, we are disposed to think, certainly in all interstitial, and, from the above observations, very probably in all tubal fœtations.

The points deducible from the above examination are—

1st. That the decidua-like membrane found lining the interior of the uterus in these cases is, in vascularity and microscopical structure, essentially the same as *true* decidua.

2d. That in extra-uterine pregnancies a decidual membrane can be dispensed with.

3d. That the delicate, membrane-like layer lining the cavity in some cases of extra-uterine fœtation is composed of elements differing essentially from those of the true decidua, and is derived from plastic lymph, and probably effused not long before the bursting of the foetal cavity.

Plates illustrative of the Anatomy of Extra-Uterine Fœtation.

PLATE I.

Fig. 1.—Ramification of villi on mucous lining of Fallopian tube.

a. Ciliated epithelium still remaining.

b, b. Villi.

c, c. Capillary (dilated) of lining of Fallopian tube.

„ 2.—Network of capillaries on the decidual membrane.

„ 3.—Ramifications of villi on the interstitial cavity in Pl. II.

a, a. Villi.

b, b. Uterine sinus.

„ 4.—Ditto ditto.

a. Villi.

b. Maternal capillary.

PLATE II.

Illustrating the case of interstitial pregnancy described in the preceding paper. The drawing shows the position of foetus, the decidual membrane, and the evolution of the uterine tissue.

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ON
RUPTURE OF THE POPLITEAL ARTERY
AND
POPLITEAL ANEURISM.

By ALFRED POLAND.

At first, it was our intention to have published an original communication on complete laceration of the popliteal artery produced by external violence, without any lesion of the integument, based upon three cases which had come under our especial treatment at Guy's Hospital within the past few years. But in so doing we considered that, by confining ourselves to these three isolated cases, we should be necessarily curtailing a very interesting subject, and should not well arrive at any satisfactory results. The symptoms, diagnosis, and treatment of this rare accident, as well as that of ruptured aneurismal sac, we found would well bear a thorough investigation; and this could only be done by collecting a sufficient number of cases, and, by comparing them together, thus elucidate the subject in all its possible bearings. Hence, then, we have determined to publish, in the 'Guy's Hospital Reports,' cases collected from all sources, the majority of which are unconnected with that institution, an objection the difficulty of which we could not overcome. Collective experience is far more valuable than individual experience—a fact much overlooked in the present day, when general conclusions are often deduced from one solitary instance. In introducing the

cases of other surgeons, as detailed in the public journals, we have judged it but fair to append their remarks which may accompany each.

The following is a summary of the lesions which we intend to consider :

A. *Direct or immediate rupture of the popliteal artery.*

- a. Complete laceration ; the artery being torn completely across, and ends separated.*
- b. Incomplete laceration ; where there is only a partial lesion of the coats, as caused by fracture, diseased bone, ulceration of the artery, &c.*

B. *Indirect ; viz., the rupture of an aneurismal sac in connexion with the popliteal artery, whether arising from injury or otherwise, and comprising :*

- a. Ruptured sac.*
- b. Perforation of sac by diseased bone, &c.*
- c. Ulceration of sac.*

We have thus omitted all lesions of the popliteal artery accompanied with breach of surface, such as punctured, incised, lacerated, and gunshot wounds.

A. DIRECT OR IMMEDIATE RUPTURE OF THE POPLITEAL ARTERY.

SERIES I. *Complete laceration of all the coats of the artery, the ends being torn asunder and separated.*

Now at the very outset of our inquiry, supposing we had taken our Guy's Hospital cases as fair specimens of this accident, we should have argued that rupture of the popliteal artery was generally associated with severe and complicated injuries of the knee-joint ; that the forcible separation and tearing asunder of the artery was due to the displacement of the femur backwards from off the tibia, the vessel being caught by the edge of the inner condyle or the intercondyloid portion

of bone, the ligaments of the joint having been wholly or partially lacerated; that the rupture thus arose from causes acting from within outwards. But we shall find that such is not always the case; and although there can be no doubt that the depth of the artery from the surface, its protection by the hamstring and heads of the gastrocnemius muscle on either side, and the filling up of the space with much fat, cellular tissue, and dense fascia, strongly defending it from causes of injury acting from without inwards, so much so that the possibility of its occurrence is denied by some, yet it may and does occur under such circumstances, as will be seen on reference to the cases.

The most usual form of accident met with, as associated with rupture of the popliteal artery, is compound dislocation of the knee-joint, showing at once the immense amount of force and laceration requisite before this elastic vessel will give way; and knowing this, the surgeon is not prepared to meet with a similar accident to the vessel when unassociated with breach of surface. On the other hand, the artery, even in compound dislocation, may escape, as is recorded by Sir A. Cooper in his work on 'Dislocations,' in a case where the femur was thrown behind the tibia on the outer side of the head of the latter; the external condyle dislocated backwards and outwards, and projected through a large opening in the integuments; the thigh-bone was twisted outwards, and the internal condyle advanced upon the head of the tibia. The limb was amputated, and, on examination, the vastus internus was found to have a large aperture in it, just above its insertion into the patella; the tibia projected forwards; both heads of the gastrocnemius were torn through, and the capsular ligament so completely lacerated, posteriorly, that both the condyles of the femur were seen projecting through the gastrocnemius; neither the sciatic nerve, the popliteal artery and vein, the lateral, nor the crucial ligaments, were ruptured. Here the whole of the force seemed to have been expended on the sides, and not on the centre, of the back part of the knee-joint.

It is in the complete dislocations, where the crucial and lateral ligaments are lacerated, and the condyles of the femur thrust directly backwards through the centre of the popliteal space, that the artery gives way; or in those compound dislocations,

where the head of the tibia is thrown backwards from off the condyles, tearing through the vessels and appearing at the external wound. Such instances are frequently recorded. In these cases the ruptured vessel is at once apparent, and the nature of the injury such as to require immediate amputation; and it is a remarkable fact, how often there is so little or even no hæmorrhage after the first gush of blood has issued from the wound; the forcible laceration of the vessel, so highly favorable to the plugging of the torn ends, is almost immediately succeeded by coagulation, and in a few hours is of such firmness and solidity as to allow of much manipulation and movement, without disturbance. This was well exemplified in a case that was brought to Guy's Hospital many years ago. The man had fallen down a well, and one of his legs, during the descent, having been caught at the edge of the well, was forcibly doubled up, bending the knee in the contrary direction, so that the toes touched the bend of the thigh. The condyles of the femur protruded through a large wound in the popliteal space, and he lost some blood. In this condition he was sent to the hospital in a very shaky vehicle, and arrived about three hours after the accident. On admission, the ruptured ends of the popliteal vessels were lying exposed in a large wound in the popliteal space; no ligature had been applied, and no hæmorrhage had taken place during the journey. The ends of the vessels were firmly plugged with coagulum, and the upper end of the artery could be observed pulsating most vigorously and forcibly, and yet completely under the command of the plug. There was also a fracture of the thigh in its upper third on the same side; short splints were applied to steady this fracture, and the limb amputated at the junction of the middle with the lower third. A good recovery was made, and the fracture united firmly.

Not only in compound dislocations, but in other severe injuries about the knee, is the artery torn through and without hæmorrhage. In these cases, like the preceding, the injury is at once perceived, and amputation, as the only resource, performed; thus the following cases are examples of this circumstance:

A patient was brought into Guy's Hospital with a compound fracture of the leg, extending close to the knee-joint; amputation was performed above the knee.

On examining the popliteal vessels, they were found both torn through, but no external communication with the torn ends. Scarcely any blood had been lost; the ends had not retracted, but the orifices of the artery were contracted and filled with a small quantity of coagulum; a web of membrane was enveloping the extremity of the vessel. The vein was also torn, and its extremities appeared puckered, and also covered with cellular membrane. Quicksilver dropped into the vessel did not escape. In this case two causes prevented hæmorrhage—the cellular sheath enveloping the divided extremities of the vessel, and the contraction of the muscular coat. (See Prep. 1509, Guy's Museum.)

A similar case was admitted into Guy's, under Mr. B. B. Cooper. A man, æt. 32, was struck by a plate of iron weighing 4 cwt., and at red heat, on the outer part of the thigh, just above the knee, jamming him against the wall with fearful weight. There was a large vertical wound over the outer part of the knee, the vastus externus torn through, as also the capsule of the knee-joint; the femur fractured in its lower fifth, and protruding through a wound in the popliteal space. There had been but little hæmorrhage. Amputation was performed two hours after the accident. The popliteal vein and artery were completely torn through; both ends of the artery were filled with a large coagulum. (See Prep. 1515⁸².)

We have thus somewhat digressed from our subject, but the foregoing remarks were introduced, in the first place, to show that it requires much force to rupture a popliteal artery; and secondly, that when ruptured completely across, there may be little or no hæmorrhage after the first immediate gush. These points will have to be borne in mind in investigating the class of cases for our consideration; the essential difference being the absence of lesion of surface and the want of a vent for the immediate escape of blood, so that in the majority of these cases tension takes place, and rapid gangrene ensues.

Of complete rupture of the popliteal artery without any, or but slight, external lesions, we have collected nine cases from the British journals; and of these, it is singular, three came under our especial notice and treatment at Guy's Hospital.

Eight were males, and one female; 3 of the age of 30, one aged 32, one aged 36, one aged 46, and 2 aged 50; and all due to violence and injury.

1. The more precise nature of the *causes* of the injuries in these cases were—

a. Those acting from without inwards.

In Case 2 it was maintained by the man that he was kicked in the popliteal space by a horse, and it was thought so probable by the surgeon, that, acting upon this and having decided the case to be one of ruptured artery, he cut

down upon the vessel, and tied the two lacerated ends; but when the limb came to be examined (as amputation had to be performed afterwards), it was found that the injury had been caused by a dislocation of the knee, and the kick could not have produced such an amount of injury; and, on careful inquiry, it turned out that the man was intoxicated, and was showing some passers by the methods of horse-taming, and while attempting to fasten the fore leg it was observed that he was thrown down, and his leg was doubled up under him; whether the horse bore his weight on the man could not be ascertained. In Cases 3, 4, and 9, it was the wheel of a heavy cart or van passing over the ham of the leg. Case 5, while standing a little raised upon the toes and leaning forwards, a sack of wheat fell from a height of seventeen feet, and struck the back part of the leg, about the bend of the joint. Case 6, whilst sitting on a square block of stone, was struck by another, which drove the popliteal space or ham against the block on which he sat. Case 7, the man was drawn into a revolving shaft, which carried him round and dashed him two or three times against the wall.

In two out of these four cases (Cases 4 and 8) the popliteal vein was ruptured with the artery, and probably also in Case 6; in these instances there was a laceration and crushing of the parts intervening between the integuments and joint, these latter structures themselves not being involved.

b. Those acting from within outwards.

In Cases 1 and 2 the rupture was entirely due to the forcible separation of the ligaments of the knee-joint, and displacement of the femur backwards; the posterior and crucial ligaments were all lacerated, and the artery torn through, but the vein, nerves, and integuments remained entire.

In Case 3 it is questionable whether the partial dislocation of the knee, or the passage of the cart-wheel over the joint, was the cause.

In Case 7 the accident is said to have occurred by a violent exertion in vaulting over a boat, but here the state of the knee-joint is not mentioned.

In Cases 4 and 5 it is also questionable whether the probable injury to the knee-joint was not the primary cause; for, from the examination of the limb, although seven weeks after the accident, the condyles of the femur were found exposed, and the greater part of the ligaments had sloughed.

In this latter class of cases there is a forcible wrenching and separation of the femur from the tibia, and it appears that the popliteal artery became torn through, the vein and nerves almost entirely escaping. This we can readily understand, for the artery is next and closest to the femur and joint, and would be the first vessel or structure implicated.

2. The symptoms and effects produced by this lesion.
—We shall treat these separately, in the order of their occurrence.

a. The sensation of something having suddenly burst or given way in the ham.—The nature of the accident is generally so severe, and attended with such violence, as to preclude any information on the part of the patient respecting this symptom, one which is of great importance to the surgeon in ascertaining the bursting of an aneurism, or of an artery, in a more exposed situation. It was not noticed in either of the nine cases.

b. The sudden tumefaction and swelling of the popliteal space, rapidly increasing and extending above and below in the course of the vessels, greatly altering the shape and contour of the limb. This symptom is the most important and most reliable evidence of lesion of some large vessel. The extent and rapidity of the effusion of blood will depend upon certain conditions; thus, if the artery be torn across above the bend of the joint, it will be more extensive, and become more superficial, forming a large and evident tumour; but if the artery have given way below the joint, under the bellies of the gastrocnemius muscle, the blood will diffuse itself between them, elevating the muscles of the calf, and causing a uniform and general enlargement of the upper part of the leg, inducing much tension and pain, although but little extravasation need have taken place.

The following are the conditions noticed in respect to this symptom in our cases :

In Case 1 there was much swelling and tension, which, in three or four hours, increased to an enormous size, extending some distance down the calf.

In Case 2, observed for the first time twelve hours after the accident, there was much distension and tension extending down the calf, and increasing slowly.

In Case 3 the ham and leg were enormously swollen and distended.

In Case 4, soon after the injury, there was but slight swelling on the inner side of the knee, but in a few hours the swelling increased.

In Case 5, within five minutes of the accident, the leg became swollen to nearly double its natural size.

In Case 6 the knee was larger than the sound one, and continued to increase in size until it at last became greatly swollen.

In Case 8 there was considerable swelling, which increased and extended, reaching up the thigh and down the leg.

In Case 9, although there was a small, deep wound in the ham, and venous hæmorrhage therefrom, there ensued rapidly a large effusion in the limb, causing distension.

c. Condition of the skin covering the swelling depends upon the length of time elapsing after the injury, and the amount of damage done to the soft parts.

In Case 1 the skin was at first natural, but afterwards became tense, shining, and very elastic, and appeared as if about to burst.

In Case 2 the skin was slightly discoloured, and there was the mark of a bruise on the inner side of the leg, just below the popliteal space.

In Case 3 there was no bruise, but a slight wound along the inner side of the knee, through which the inner condyle could be felt, but no hæmorrhage or presence of blood; it appeared wholly unconnected with the large swelling, which latter felt firm, elastic, and fleshy, and the skin over it of a mottled appearance.

In Case 5 it was tense, hard, and shining, and the whole leg below the knee presented the well-known purple and mottled appearance of ecchymosis; above the knee it shaded off into a fawn colour, which reached nearly to the groin on the inner side, but not so high on the outer.

In Case 6, half an hour after the accident, it was of a dark, reddish-blue colour, evidently from the bruise and extravasation of blood; it afterwards became quite a blue-black.

In Case 8 there was considerable ecchymosis, which increased and extended up the thigh and down the leg; on the third day the discoloration was very extensive, and the whole surface of the calf of the leg of a grayish-purple hue.

In Case 9, integuments distended, and exploratory wound became sloughy and discharged ichorous and bloody matter.

In the first 3 cases there was little or no ecchymosis, owing probably to the cause of the rupture being from within outwards; whereas, in Cases 5, 6, and 8, much extensive ecchymosis existed, owing to the severe direct contusion of the skin and soft parts. In Case 9 there was a small, deep wound, from which there was a free hæmorrhage, and yet a large, rapid effusion in the ham ensued; this case, by rights, ought not to have been included in the series, yet it possessed characters similar to the other lesions, and we thought it advisable to append it.

d. The absence of any pulsation in the swelling or tumour.—In all these cases there was not the slightest pulsation; pressure on the femoral was tried in one case, but it had no effect on the tumour; and in another, the swelling was carefully examined, both by the hand and the stethoscope, and no beating was either felt or heard. It is the absence of pulsation which throws the surgeon off his guard, who generally expects

to find pulsation in cases where an artery has been ruptured. In the ham the artery is deep ; the first gush of blood is large in quantity, and sufficient to distend the space and press upon the vessel, while the torn ends are rapidly closed by coagulum, hence the want of pulsation in the swelling.

e. The pulsations in the tibial vessels, noticed in 6 of the 9 cases.

In Case 1 it was thought that they pulsated feebly at first, but in a few hours ceased to beat. In Cases 2, 3, 4, and 6, there was no pulsation whatever. In Case 8 the anterior tibial artery was examined on the second day, and it *was thought* that pulsation could be perceived; and on the third day it was said to be very feeble; but on the fourth day there was no pulsation in the dorsalis pedis artery. The pressure of the effused mass of blood in these cases is so great as to press upon the vessels below the injury, and thus prevent their pulsation. In the instance in which the tibials were thought to pulsate, it is more than probable that it was the deceptive pulsation of the surgeon's fingers.

f. The presence or absence of pain, depending upon the amount of tension of the nerves, or injury done to them.

Thus in Cases 1 and 8 there was great pain, which increased as the distension came on; and in the latter case it amounted to great severity. In Case 5 there was entire loss of sensation as well as motion below the knee, which was afterwards explained by finding the nerves torn across. In Cases 2 and 3 there was little or no pain complained of; and in Case 8 there was loss of sensation in the foot.

g. The temperature of the limb.—A sudden diminution in the temperature of the limb is often a concomitant symptom when the main vessel has burst.

The leg and foot were of lower temperature in Case 3; they were cold in Cases 2 and 4. In Case 5 the whole leg was as cold as marble, the coldness gradually subsiding and ceasing near the groin; and in Case 8, the temperature of the lower part of the limb was much diminished, and became very sensibly so on the fourth day.

h. Edematous condition of the limb, generally occurring a few days after, and in those cases where the effusion was great, and exerting compression on the arterial and venous vessels; this was only recorded in 2 cases (3 and 8).

i. Formation of abscess and disturbance of plug in ruptured

vessel, causing secondary hæmorrhage, which proved fatal in Case 9.

k. Gangrene of the limb is a natural sequence of a ruptured popliteal artery, not so much due to the lesion of the vessel itself, but to the severe attending complications and excessive injury done to the neighbouring tissues.

In all the cases, except where immediate amputation was performed, gangrene resulted. In Cases 1, 2, and 7, it might perhaps be referred to the treatment employed, viz., ligature of the vessel, either at the seat of rupture, or at the proximate end; but in Cases 5, 6, and 8, no primary treatment was adopted; hence we have fair evidence of the natural sequence of this lesion.

In Case 9 (hardly belonging to this series), by way of contrast, there was a small wound which was dilated by incision, and thus took off considerable pressure and tension, hence gangrene did not supervene.

The progress and termination of this lesion when left alone, without any operative measures, are well exemplified in 4 of these cases.

In Case 5, on the second day there was some return of warmth just below the knee, and the limb sensible to touch as far as the ankle; on the third day a return of sensation in the great toe, and of all the other toes on following day. During the ensuing four days sensibility and temperature remained about the same, and on the eighth day numerous vesications were forming below the knee; and by the eighteenth day the whole of the lower leg, with the exception of a small portion of the upper and inner surface, was converted into a gangrenous mass, and the separation of the dead from the living structures fairly began. On the forty-second day knee-joint completely opened from behind; limb amputated; recovery.

In Case 6, on the eighth day, vesications, filled with a bloody fluid, formed on outer side of leg over fibula, and whole limb manifestly about to pass into a state of gangrene. Patient's countenance and body had assumed a jaundiced hue; pulse very quick; tongue foul; countenance sunken and skin hot; head wandering. Free incision; morphia in abundance, and health improved. The mortification of the limb became complete; a line of separation formed about four inches below the knee in front, and extended behind towards the ham. On thirty-second day, the dead parts having almost entirely separated from the bones all round, those which remained were cut through where dead, the bones sawn through about six inches below the knee, and the lower part of limb removed, leaving an irregular and, in fact, a granulating stump; recovery.

In Case 8 on the fifth day the foot was evidently gangrenous; it was not swollen, but very cold, and the toes livid. This coldness extended to about three inches above the ankle, and was sharply marked off from the warmer parts. The patient had copious perspirations, but no rigors; his appetite was good, and he did not feel ill. For several days the gangrene did not extend materially; but

the whole calf was much infiltrated with blood, and there was a large collection in the popliteal space. On the fourteenth day the coldness had extended higher up, and the skin of the calf was seen to be sloughing. Amputation was then performed; recovery.

In Case 9, the discharge through exploratory incision was ichorous and bloody, and the wound turned sloughy; the swelling became somewhat diminished, and on thirteenth day wound assumed a healthier appearance, and things seemed fair for recovery, when on sixteenth day sudden and profuse hæmorrhage occurred and death.

DIAGNOSIS.—The sudden and rapid swelling in the popliteal space, the loss of pulsation in the tibial vessels, the diminished temperature in the limb, and the tense, and often discoloured, state of the integument, would lead one to suspect and prognosticate that the main artery had burst. Pulsation in the swelling is absent, and its absence must not lead us to the supposition that the vessel is entire. We shall find that this negative symptom is associated with ruptured aneurismal sac, and has too often led the surgeon astray, so that he has thus totally overlooked the real nature of the case. In the 3 cases that came under our treatment, we successfully diagnosed the rupture of the vessel from the above facts, having observed such symptoms to accompany ruptured popliteal aneurisms.

TREATMENT.—We will first take a glance at the treatment adopted in the 9 cases, and then offer a few suggestions as to the best mode of proceeding in this injury.

In 4 of the cases no particular line of treatment was carried out, and no primary operative measures enforced; 3, however, recovered, and 1 died.

In Case 5, the limb became gangrenous, and was allowed to separate spontaneously, and this was being performed naturally, until the man's powers began to flag, when the surgeon had to amputate the limb above the thigh, with good result.

In Case 6, gangrene also followed, and the tense parts relieved by incision on the seventh day; nature here again undertook amputation, and the limb separated below the knee successfully.

In Case 8, the gangrene continued slowly advancing and exhausting the patient, when, on the fifteenth day, amputation was performed, and recovery.

In Case 9, an incision had been made in the ham soon after the injury, and thus gangrene was averted, but fatal secondary hæmorrhage took place on sixteenth day.

In the remaining 5 cases immediate operative measures were adopted, and all died.

In Cases 3 and 4, immediate amputation was performed.

In Case 2, a long incision was made in the ham, and the two ends of the ruptured artery ligatured; gangrene, however, supervened, when amputation was performed on the third day, and death resulting in forty hours.

In Cases 1 and 7, the femoral artery was ligatured; gangrene resulted in both; in Case 1, followed by rapid death, and in Case 7, amputation was performed on the twenty-second day, but did not save the patient, who died three hours after the operation.

Now, in all these cases (except Case 9, which was attended with immediate wound and incision), the limb was sacrificed, either by gangrene or amputation.

In Case 9, a recovery without loss of the limb might have been anticipated, for on the thirteenth day the wound in the ham had assumed a healthier appearance, and there was no evidence of gangrene, and the patient died of sudden profuse hæmorrhage.

In treating this injury, our first consideration will be the propriety of preserving the limb with safety to the life of the patient. Were it not for Case 9, and the remarks of Mr. Guthrie, appended to Case 6, we should not hesitate for one moment in advocating amputation of the limb. In Case 9 the immediate incision relieved the tension, gangrene did not follow, and the limb was apparently saved; and in Case 6, Mr. Guthrie says, "if the incision had been had recourse to, during the first two or three days, and the artery sought for, and secured if found bleeding, it is possible the mortification might have been prevented; although it is probable, from the pressure arising from the great extravasation and coagulation of blood, that the collateral circulation was so much impeded, as not to have been able to maintain the life of the limb below, even during that time." The only justification for saving a limb would be the following circumstances; viz., when the rupture has occurred from a blow, or injury from external causes, without apparent injury to the knee-joint, and without much damage to the neighbouring soft parts; when there is only a certain amount of extravasation, and, although there be no pulsation in the ham or tibial arteries, yet it does not form a sufficient impediment to the collateral circulation to cause gangrene, as in Case 9; when the patient is of good constitution, temperate habits, and young. Should such a favorable

condition of things warrant us in saving the limb, one of the following measures will have to be carried out :

Ist. *To leave the limb to nature's own resources*, as in Cases 5, 6, 8, and 9. This plan in all these cases was unintentional, as the severity of the nature of the injury, viz., a ruptured popliteal artery, was not at first recognised. In these (Cases 5, 6, and 8) gangrene set in, and it required much constitutional effort to withstand the dangers and risk of this complication; in Case 6 it was fortunately arrested, and the limb separated below the knee; in the other 2 cases amputation had, after all, to be performed at the twenty-second and forty-fifth day; in one of which it proved fatal. Case 9 was interesting in many points, as showing that a ruptured popliteal artery may not necessarily be followed by gangrene, where the tension of the skin is relieved by incision; and, although escaping this one mischief, the incision was the probable cause of the secondary hæmorrhage which took place on the sixteenth day, for immediate pressure on the ruptured ends had been taken off, but the plug in the vessel not sufficiently firm to resist the arterial impulse. Had the injury been suspected, and had the incision been made larger, the clot turned out, and the torn ends ligatured, as in Case 2, a recovery might have resulted.

2d. In saving the limb we must or ought to guard against further extravasation by means of *compression of the femoral artery in the thigh and groin*, which must be carefully and judiciously employed. This can only be successfully performed in such rare instances as in Case 9, for in the majority the extravasation is sudden, immediate, and in such large quantities as at once to impede all collateral circulation in the limb, the mischief is done, and the speedy gangrene of the limb inevitable, and then the compression would not be of any service. In Cases 1, 4, 6, 8, and 9, compression might have been useful, if it had been employed early at the time of their admission into the hospital.

3d. *Should we cut down and tie the ruptured ends of the vessel*, as is ordinarily done in rupture of other arteries? This seems to be the most rational treatment, and was adopted in one of the cases (Case 2), attempted in two others (Cases 6 and 9), and regretted not to have been employed in a fourth

(Case 6). By this measure we relieve tension and prevent any further hæmorrhage.

Where no complication existed otherwise than a ruptured artery, there can be no doubt as to the propriety of the proceeding; and it is not at all improbable that, had no complication existed in Case 2, a more satisfactory result might have been anticipated.

The operation is generally extremely difficult, on account of the great depth to reach the wound, and the obscurity rendered by effused, coagulated, and infiltrated blood. This was evinced in Cases 6 and 9, where an incision was made, and the artery sought for and not found; but its beneficial effect was to allow of all the coagula to be turned out, and in this way getting rid of one source of subsequent irritation, knowing that the quantity of blood is too great to admit of absorption.

4th. *Ligature of the femoral artery at a distance*, as in ordinary aneurism performed in Case 1 and Case 7. In both, gangrene supervened, and the operation did not seem to place the patient in any more favorable condition, as in nearly all the cases early plugging of the vessel had taken place. The remarks respecting compression will equally apply here; ligature of the artery being but of little service when the whole mischief has taken place.

Respecting *amputation* of the limb, we have already referred to this measure as the treatment most appropriate in ordinary cases of ruptured popliteal artery; it is the one indicated by nature. When we consider the causes of the accident, the immense violence and force required; the complications involving the soft parts and knee-joint; the sudden outburst of a large quantity of blood in a confined space, bound down by dense fascia from behind, with the solid femur in front, and tense hamstring-muscles on either side, we can no longer wonder that all circulation in the limb below should be cut off, and death of the part result. But here a question arises as to whether amputation should be primary or secondary? There can be no doubt that when a limb is so thoroughly injured as to preclude all hopes of saving it, the primary operation ought to be performed, instead of allowing the patient to run the risk of passing through all the dangers attending

gangrene, which necessarily induces great constitutional irritation and disturbance. The fatal issue of the primary amputation in the present series does not in the least invalidate the propriety of this measure, for, in two of the cases, death would in all probability have taken place independent of the operations, from the severity of the shock, as these cases died in two and sixteen hours respectively after its performance. The third case, which has been recorded as primary amputation, was in a measure a secondary operation, inasmuch as it was performed on the third day, after gangrene had set in, and after ligature of the femoral had been employed.

As regards secondary amputation, it was had recourse to in 3 cases, and was performed on the fifteenth, twenty-second, and forty-fifth days; 2 recovered and 1 died three hours after the operation. In another case, nature successfully performed the secondary amputation, assisted by the surgeon dividing such tissues which could not readily be thrown off. These go much in favour of the latter practice; but in pursuing the history and progress of them, we find that much suffering and great risk of the patient's life was undergone.

Again, in our secondary amputations, after gangrene has set in, should we amputate while it is spreading, or wait until a line of demarcation has taken place? This question we shall not enlarge upon; each plan has its advocates; and space will not permit us to treat this point in all its bearings in the manner which we should feel inclined to do.

Porter states that amongst a large number of cases of amputation in spreading gangrene, he has never seen one recover, where the origin of the mischief was an extensively diffused aneurism.

Guthrie says, in his remarks upon the Case 6, "Experience has demonstrated in too many cases of the kind that the formal operation of amputation at this time, as recommended by most modern surgeons, would in all probability have cost him his life."

We will now give a detailed account of each case, as reported.

Table of Cases of Complete Rupture of the Popliteal Artery.

No.	Name.	Age.	Occupation, &c.	Cause.	Primary operation.	Effects of injury or operation.	Secondary operation.	Result.	Surgeon.	Hospital.
1	Male	50	Stout, bloated	Fell some distance with leg doubled up on thigh	Ligature of femoral eight hours after	Rapid gangrene	—	Death on fifth day	Poland	Guy's
2	Thomas H—	30	Cabman ; intemperate	Said to be from kick of horse, but he fell with leg under him	Long incision in ham, and the ends of ruptured artery ligatured	Gangrene	Amputation on third day	Death forty hours after	Poland	Guy's.
3	John F—	32	—	Passage of cart-wheel over thigh	Immediate amputation	—	—	Death in sixteen hours	Poland	Guy's.
4	John B—	30	Locksmith; intemperate	Wheel of heavy van passed over leg	Immediate amputation	—	—	Death in two hours	South	St. Thomas.
5	James C—	46	Labourer	Sack of wheat fell upon bend of knee	None	Gangrene ; attempts at spontaneous reparation	Amputation at seventh week	Recovery	Cooper	Liverpool Infirmary.
6	Richard C—	50	Mason	Struck on ham by block of stone	None	Gangrene, natural amputation	Long incision on seventh day	Recovery	Guthrie	Westminster. Glasgow.
7	John Z—	30	Sailor	Violent exertion in vaulting over a boat	Ligature of femoral	Gangrene	Amputation on twenty-second day	Death three hours after	Lawrie	
8	James T—	36	—	Caught in revolving shaft, and great contusions	None	Gangrene	Amputation on fifteenth day	Recovery	Cesar Hawkins	St. George's
9	Anne M—	—	Intemperate	Wheel of coach passed over lower and back part of thighs	Wound dilated ; no bleeding vessel found	Sudden hæmorrhage on sixteenth day	—	Death immediate	Quoted by Travers	Guy's.

CASE 1.—*Complete rupture of popliteal artery ; ligature of femoral ; gangrene ; death.*

Æt. 50. Exceedingly stout and bloated. Said to have fallen down some distance with leg doubled up on thigh, and he was admitted a few hours after the accident. There was no wound or fracture about the thigh or leg, but the back part of the popliteal space was much swollen and tense ; this gave no indication of pulsation. The man complained of severe pain down the calf of the leg, and a sense of tension about the knee. The tibials were thought to pulsate feebly. Evaporating lotions were ordered. In the course of three or four hours the swelling had increased to an enormous size, extending down the calf to some distance. The skin was tense and shining, and very elastic, as if about to burst ; it had no pulsation, and pressure on the femoral produced no effect. The tibials had ceased to beat. A consultation was held, and it was considered advisable to ligature the femoral artery. This was performed by Mr. Poland. The operation was followed by great relief to the patient, who stated that a great weight had been taken off, and that he had less acute suffering. On the following day the tension had subsided, and the whole of the swollen parts were soft ; the temperature of the limb was good. On the third day gangrene set in, and was so rapid as to reach the knee in twenty-four hours. He died on the fifth day.

Examination of the limb.—The popliteal artery was completely torn across, opposite the bend of the knee ; the vein was entire ; there was much extravasated blood about the ham and under the gastrocnemius muscle. There was rupture of the ligaments of the knee-joint, allowing a displacement of the femur backwards from off the tibia.

CASE 2.—*Complete rupture of the popliteal artery ; artery laid bare and both ends tied ; amputation ; death.*

T. H—, æt. 30.—Admitted into Guy's Hospital under Mr. Poland. A cabman of intemperate habits. While drunk was stated to have received a severe kick from a horse in the left popliteal space, which was immediately followed by swelling of the part, and inability to stand on the leg. He was brought to the hospital in about twelve hours. The whole of the popliteal space was much distended and tense, the swelling extending some way down the calf ; the integuments were slightly discoloured, and there was a mark of a bruise on the inner side of the leg, just below the popliteal space, the site of the kick. There was no pulsation whatever in the popliteal swelling, and the position of the tibia, with regard to the femur, was quite normal. The pulsation in the anterior and posterior tibial arteries could not be felt. The leg and foot were cold, and he could not move the toes, although he had not entirely lost sensation.

Mr. Poland gave his opinion that the case was one of ruptured popliteal artery, but that he would not proceed to immediate operation until the patient had some little rest from his journey. Ice was applied over the swelling, and the leg and foot covered with cotton wool and wrapped up in flannel ; a pill containing a grain of opium was administered, and repeated at intervals of two hours.

Seven hours after admission the swelling and pain had not been checked, so that he was placed under the influence of chloroform, and turned on his side, so as to expose fully the back of the knee. Mr. Poland made an incision, of from seven to eight inches in length, along the course of the popliteal artery, and cleared out much coagulum, and without difficulty found the ends of the ruptured artery lying an inch and a half apart; the upper end seemed to be plugged by coagulum, and was secured by ligature; the lower end seemed to be patent, and was similarly ligatured. The popliteal vein was distinctly seen, and appeared to be uninjured, although it did not look quite normal—perhaps discolored by the effused blood; the inner head of the gastrocnemius was found torn. Further examination of the space was not made.

The man appeared to be much relieved by the operation. He passed a comfortable night, and the temperature of the limb was maintained. Symptoms of delirium tremens set in, causing much violence to the limb, but this subsided under large doses of opium and gin *ad libitum*. On the third day, thirty-six hours after ligature of the vessel, gangrene rapidly set in, when the limb was amputated above the knee. The man never rallied, and died 40 hours after the operation.

On examining the leg the popliteal vessels and nerve were carefully removed throughout their extent and dissected out, so as to be preserved; the popliteal artery was torn across, the ends, an inch and a half apart, having ligatures securely attached to both, were connected by a string of cellular tissue. The vein was entire, and pus was found close to its sheath; the nerve appeared to be bruised. (See Preparation.) The posterior and crucial ligaments of the knee-joint were completely torn through, as well as the lateral ligaments, and the condyles of the femur could be readily displaced backwards from off the tibia, so as to project into the popliteal space.

There was much extravasated blood under the gastrocnemius, as well as under the integument.

CASE 3.—*Complete rupture of popliteal artery ; amputation ; death.*

John Fitch, æt. 32, was brought to Guy's Hospital with severe injury about the knee. The accident was said to have been produced by the passage of a cart-wheel over the thigh. No fracture or bruise could be detected, but there was a small wound along the inner side of the knee, through which could be felt the inner aspect of the condyle of the femur; a finger introduced into this opening could not discover any lesion of the joint, nor could it be made to extend to any great distance; there was no hæmorrhage or appearance of extravasated blood about the wound. It was therefore considered of but minor importance. The chief attention was drawn to the condition of the popliteal space and upper part of the calf of the leg; the integuments in this region, though uninjured, were enormously swollen and distended; somewhat mottled on its surface; there was not the slightest pulsation in it, but it felt firm, elastic, and fleshy; the leg and foot were œdematous, and of lower temperature than the sound limb; there was no pulsation in either tibials.

The case was considered to be one of ruptured popliteal artery. Mr. Poland performed immediate amputation; but the man never rallied, dying sixteen hours afterwards.

Upon examining the limb, some extravasation was found under the integuments in the popliteal space and calf of leg; but the chief effusion had taken place under the

gastrocnemius and soleus, extending down the leg. The popliteal artery was completely torn across in its centre, exactly opposite the bend of the joint; the ends were an inch to an inch and a half apart, and both extremities were well plugged. The vein was entire, and the nerves uninjured. On carefully examining the joint, the posterior ligament was torn through, as also part of the internal lateral ligament, exposing the inner condyle of the femur, a small piece of which was broken off. The crucial ligaments were entire. The inner condyle of the femur was readily moved backwards. The head of the fibula was dislocated from the tibia.

CASE 4.—*Rupture of the popliteal artery and vein; immediate amputation; death in two hours after.*¹

J. B—, æt. 30, locksmith, was admitted into George's Ward, St. Thomas's Hospital, under the care of Mr. South, on August 14th, between twelve and one o'clock a.m., having had the wheels of a heavy van pass over the ham of his left leg. There was an inconsiderable wound over the patella, and slight swelling on the inner side of the joint. There was no fracture. The man, when admitted, was exceedingly drunk, and was said to have been drinking for some days. During the night he was very violent, and the house-surgeon was sent for to see him early in the morning. He found the swelling to have increased, that the leg was cold, and that there was no pulsation in the anterior or posterior tibial arteries.

Mr. South was sent for, and immediately amputated the leg, diagnosing rupture of the artery. The man was very low, although he was well plied with stimuli, and after the operation he complained of severe pain in the precordial region, and died in two hours.

On examining the limb, the popliteal artery and vein were found to be torn through in the middle of the popliteal space. Blood was extravasated superficially, but not in large quantities, at the sides of the patella, particularly on the outside, as well as into the ham. There was no extravasation in either the anterior or posterior tibial regions. A clot of blood was found in each end of the torn artery, the clot in the proximal extremity being an inch and a quarter long, and particularly firm. There was a very considerable effusion of serum into the leg and thigh. No muscle was torn. The body was extremely muscular, and all the viscera appeared to be healthy.

CASE 5.—*Rupture of the popliteal artery; gangrene; attempts at natural separation; amputation at end of seventh week.*²

James —, æt. 46, a labourer, was admitted at the Liverpool Infirmary under the care of Mr. Cooper on the 28th of July, 1850. He stated, that when working yesterday in the hold of a ship, measuring wheat, a sack of wheat fell on him from a height of about seventeen feet. He was standing at the time a little raised upon his toes, and leaning forwards. The sack struck the back part of the right leg, about the bend of the joint, and threw him forwards. He lay for a minute or two unable to rise, until the sack was removed from over him. Within five minutes

¹ 'Lancet,' 1859, vol. ii, p. 287.

² 'Lancet,' 1851, vol. ii, p. 85.

from the time that the blow was given, the leg became swollen to nearly double its natural size, and quite powerless. He felt no pain at first, but afterwards a good deal. When admitted, his leg was swollen, as before mentioned, to nearly double its proper size. The whole leg, below the knee, presented the well-known purple and mottled appearance of ecchymosis; above the knee it gradually shaded off into fawn colour, which reached nearly to the groin on the inner side, not so high as the outer. Below the knee the whole leg was tense, hard, shining, and cold as marble; above it, the hardness, tension, and coldness gradually became less, and ceased entirely near the groin. Below the knee the sense of touch was entirely gone.

No treatment had been adopted previous to his admission. A consultation was immediately held, and it was decided to adopt merely expectant treatment, to support any returning warmth, and to wait until nature should show how much of the limb was beyond all hope of recovery, before any operation should be performed. The limb was enveloped in flannel, and a grain of morphia was given the patient at bed time, and ordered to be continued for the present.

July 29th. Just below the knee there is some return of warmth, and he is sensible to the touch so far as the ankle. He had retention of urine, and his water was drawn off.

30th.—Sensibility had returned in the great toe.

31st.—The feeling of the second, third, and fourth toes had returned, but there is none in the little toe.

From this date until August 4th the sensibility and the temperature remained about the same, and at the latter date, numerous vesications were forming below the knee; and by the 14th, the whole of the lower leg, with the exception of a small portion on the upper and inner surface, was converted into a gangrenous mass, and the separation of the dead from the living structures fairly begun. Charcoal poultices were kept constantly applied to diminish the fœtor.

September 7th.—The knee-joint is completely dead from behind. September 10th, Mr. Cooper amputated the limb about the middle of the thigh.

Examination of limb.—The lower leg, with the exception of the portion before mentioned, was converted into one disorganized and putrid mass. The cartilage covering the condyles was beginning to ulcerate in consequence of its exposure to the air, and the greater part of the ligaments had sloughed. Above the condyles where the line of separation had been, all the structures were blended into a hardened mass, covered by granulations. The upper ends of the artery, vein, and nerve were found in the line of the lower flap, and traced from that point to their termination in the granulating mass, which formed the lower boundary of the sound parts on the back of the leg. The artery was quite pervious, to within a little more than a quarter of an inch of its lower extremity, which space was occupied by a firm, fibrinous coagulum. To within the same distance from its end, the coats of the artery appeared healthy, and presented no trace of any atheromatous deposit. Near its end the coats became softer and more fragile than natural, deeply injected, and at the inner side, the internal coat was separated for a short distance from the other. At its termination the artery was slightly contracted around the coagulum. The lower extremity of the vein could not be so distinctly made out; it was slightly narrowed at about an inch before its end, then returned to its natural calibre, and finally became narrowed, and at its extremity, could not be distinguished clearly from the mass of granulation in which it lay. Immediately beneath the inner coat

of the vein, lay a narrow coagulum, extending upwards for more than an inch. The *nerve* ended in a bulbous extremity, with some ragged-looking processes extending from it, having all the appearances of the fasciculi of a nerve torn across, and separated from each other. The bulbous extremity of the nerve was much harder than the healthy portion, and when cut across, presented a denser and more uniform surface than the rest. In this dense mass several fasciculi could be seen terminating in bulbous extremities.

Remarks by Mr. Fletcher, the house-surgeon, who drew up the above report.—From these appearances, I think, it may safely be inferred that the injury caused by the blow, was a rupture of the artery, with some laceration of the coats of the vein, as evidenced by the clot lying beneath the internal coat; and I should think, by the look of the end of the nerve, that it too must have given way. The diagnosis of rupture of the artery was first considered the most probable, from the immense amount of swelling and tension, evidently due to the effusion of blood, and only to be accounted for by the rupture of some large vessel. Rupture of the nerve was not considered probable, until the dissection of the parts offered evidence of this lesion having taken place. The partially restored sensation of the limb could be fully accounted for by the supply of nervous branches for the musculo-cutaneous and long saphenous; the trunks of both being out of the way of injury.

I am not aware that I have ever seen any record of a similar case to the one which I have just recorded; and in order to account for an injury so extensive, we must take into consideration the peculiar position of the man's leg at the time of the accident; the whole of the back of the limb being in a state of the utmost tension possible, and the sack (no inconsiderable weight) falling so as to strike just below the knee; thus exerting an immense force on structures already stretched to their utmost limit, and causing laceration in those that were least yielding.

Sir S. Ballinghall, who saw the case after the amputation, mentioned that he had seen both artery and vein torn across without any injury to the nerve.

The most important consideration arising from this case is, whether it would not be better, under similar circumstances, to amputate immediately, and thus to save the patient the

confinement, pain, and exhaustion caused by waiting till nature had nearly completed the division of the living from the dead portion.

CASE 6.—*Ruptured popliteal artery; gangrene; spontaneous amputation; recovery.*¹

Richard Cook, æt. 50, a mason, whilst sitting on a square block of stone on the 23d of February, was struck by another, which drove the popliteal space or ham against the edge of the block on which he sat, giving him great pain, and otherwise greatly bruising the leg, although no bones were fractured, nor was the skin torn. The limb, on his admission half an hour afterwards into the Westminster Hospital, was much larger than the other, and of a dark, reddish-blue colour, evidently from the bruise or extravasation of blood, which appeared to be still issuing from the vessel or vessels as the limb continued to increase in size, until it at last became greatly swollen. The pulsation of neither the anterior nor the posterior tibial artery could be distinguished through the swelling the next morning. The bowels were opened, and a cold spirit lotion was applied to the calf and around the leg, and the swelling somewhat subsided, the limb becoming quite a blue-black, which, with the tenseness of the parts, distinctly indicated the effusion of a large quantity of blood. It was soon obvious that greater mischief had occurred than had been expected; and on the 2d of March, as vesications, filled with a bloody fluid, were formed on the outside of the leg over the fibula, and the whole limb was manifestly about to pass into a state of gangrene, if it had not already done so, I prepared everything for tying the popliteal or other arteries if found necessary, and made a long and deep incision on the outer and back part of the leg, through the integuments and muscles, posterior to the fibula, and removed a considerable quantity of coagulated blood from between the muscles, and from a large cavity which extended upwards into the ham without causing further hæmorrhage, and in no part of which cavity could an artery be felt. The patient's countenance and body had assumed a jaundiced hue; the pulse was very quick; the tongue foul; the countenance sunken; the skin hot; the head wandering. Poultices of linseed meal and stale beer were applied, with gentle stimulating applications. Brandy and wine in proper quantities were ordered every hour or two, with sufficient doses of muriate of morphia at night to allay irritation and induce sleep. The incision, together with these remedies, gave great relief; and on the 7th, the man seemed to have been saved from a state of the most imminent danger. On the 8th the pulse was 112, the tongue clean, the skin of a whiter colour, the bowels opened by injections. Eight ounces of brandy were given in the twenty-four hours; wine, with sago, arrowroot, jelly, oranges, and anything he chose to ask for. The greatest cleanliness was observed, and the chloride of lime used in profusion all around him. The mortification of the limb was complete; a line of separation formed about four inches below the knee in front, and extended behind towards the ham. On the 26th, the dead parts having almost entirely separated from the bones all round, those which remained were

¹ Guthrie in his "Lectures on some of the more important points in surgery."—*'Lancet,'* 1850-1, vol. i, p. 618-19.

cut through where dead; the bones were sawn through about five inches below the knee, and the lower part of the limb removed, leaving an irregular, and in part a granulating stump, with an inch of bone projecting from it.

On the 24th of May this portion was found to be loose; diluted nitric acid had been applied to its surface, and on the 20th of June it separated.

On the 16th of August, Cook left the Hospital in good health, with a very good stump, having cost the hospital £57 in extra diet.

Mr. Guthrie's remarks.—In this case there can be little doubt of the popliteal artery having been torn; and if the incision made on the 2d of March had been had recourse to during the first two or three days, and the artery sought for and secured if found bleeding, it is possible the mortification might have been prevented; although it is probable, from the pressure arising from the great extravasation and coagulation of blood, that the collateral circulation was so much impeded, as not to have been able to maintain the life of the limb below, even during that time. The incision made on the 7th saved the life of the patient, by taking off the tension of the part, and relieving thereby in a remarkable manner the constitutional irritation, which hourly appeared likely to destroy him; indeed, no one expected anything but his dissolution. When the line of separation had formed, he was evidently unequal to undergo the operation of amputation, to make a good stump, without great risk, and the red parts were therefore separated, merely for the sake of cleanliness and comfort. Experience had demonstrated in too many cases of the kind, that the formal operation of amputation at this time, as recommended by most modern surgeons, would, in all probability, have cost him his life.

CASE 7.—*Ruptured popliteal artery; ligature of the femoral; gangrene; amputation; death.*¹

John Lyle, æt. 30, sailor, has a large, diffused, pulsating swelling in right ham, caused by a violent exertion in vaulting over a boat. Ligature of the femoral; came away on 10th day. Secondary hæmorrhage. Gangrene; amputation performed on twenty-second day. Death in three hours.

Examination of limb.—The vessel in the ham was found fairly torn across, and the severed ends separated half an inch.

¹ 'Med. Gaz.,' vol. xxxi, p. 634. Dr. Lawrie's collection in Glasgow Infirmary.

CASE 8.—*Ruptured popliteal vessels; gangrene: amputation on fifteenth day; recovery.*

James T—, æt. 36, admitted, in the morning of October 6th, 1858, into St. George's Hospital, under Mr. Cæsar Hawkins. His apron had been drawn into a revolving shaft, which carried him round and dashed him two or three times against the wall. He was not stunned. On admission he was found to have sustained trifling injury to the face. There was considerable ecchymosis and swelling in the right popliteal space, with great pain. The left leg was a good deal bruised. He complained of dull pain down the middle of the back, and of numbness of the fingers and arms, the muscles of which contracted but feebly; and of pain when he moved his arms. There was no paralysis of the lower part of the body, and no sickness. By the middle of the day, the popliteal ecchymosis and swelling had increased and extended; there was some loss of sensation in the right foot, and to a less extent in the left also. As no pulsation could be felt in the extravasated blood, it was hoped that the injured vessel might prove to be merely a vein, and that the parts might recover themselves. A free dose of laudanum was given, and good diet allowed.

Next day, the ecchymosis had increased both in size and extent, reaching up the thigh and down the leg, and being most marked on the external surface. Pressure gave great pain, especially in the popliteal space. The lower part of the limb was much diminished in temperature. The sensation in the sole of the foot was still diminished. He was recovering power in the upper extremities; the face was very pale, and the tongue pale and tremulous. The limb was wrapped up in flannel, and the laudanum repeated. The anterior tibial artery was examined, and it was thought that pulsation could be perceived in it.

On the third day the swelling remained the same, but the discoloration was very extensive. The whole surface of the calf was of a grayish-purple hue, and there was some sero-sanguineous oozing both from this part and from the popliteal region. The pulse was quick and feeble. The anæsthesia had disappeared, except in the sole of the foot. The pulsations of the tibial artery were very feeble.

On the fourth day the tenderness of the limb was less; the temperature of the foot was very decidedly diminished. The ham was again examined, both with the hand and stethoscope, but no beating was either to be felt or heard. On the inner side of the knee the anastomotic artery could be distinctly felt enlarged. There was no pulsation in the dorsalis pedis.

On the fifth day the foot was evidently gangrenous; it was not swollen, but very cold, and the toes livid. This coldness extended to about three inches above the ankle, and was sharply marked off from the warmer parts. The calf of the leg was very tender to slight pressure. He had copious perspirations but no rigors. His appetite was good, and he did not feel ill. It was decided to defer amputation, as his health was suffering so little, in order to see whether it would be possible to obtain a flap below the knee. Warmth was applied to the toes, and generous diet with laudanum given.

The case was watched for several days without any fresh symptoms presenting

¹ 'British Med. Journal,' January, 1859.

themselves, and the gangrene did not extend materially ; but the whole calf was so much infiltrated with blood, and there was so large a collection in the popliteal space, that it was felt that it would be unsafe to form a flap from the parts below the injury to the vessels. Still, even up to two days before the operation, the vitality of the foot was not quite destroyed, for capillary action could be perceived, although foul gas had collected in the cellular tissue (and was let out by incision), and sensation was abolished.

On the fourteenth day, however, the coldness had extended higher up, and the skin of the calf was seen to be sloughing. Accordingly amputation was performed next day through the lower third of the thigh. At the operation it was noticed that the femoral artery was partially closed by a clot, which, however, still allowed some passage for the blood, so that it was necessary to use a ligature.

The man recovered and left the hospital.

On examining the limb, it was found to be gangrenous as high as the upper part of the calf, and there was some ecchymosis in the popliteal space above the fascia. Underneath the deep fascia of the leg was a large abscess, containing pus mixed with blood-clot and foul gas, which infiltrated the superficial muscles of the calf. The deep muscles of the calf were comparatively healthy. The superficial cellular tissue was much thickened. The short saphena vein was entire and pervious. The popliteal vein, just below its junction with the saphena, was broken across ; the two ends being separated by an interval of about one and a half inches. The lower end of the vein was blocked up by coagulum, adherent to its walls, and extended below its bifurcation. The upper end was empty ; the coats of the vessel at its point of rupture were somewhat contused, but not otherwise altered. The vein and artery above the seat of rupture were closely matted together. The mouth of the femoral vein, where it had been cut through, stood open. The femoral artery, where it had been cut through, was partially closed by a small clot. The popliteal artery was ruptured at the same place as the vein, and the ends separated to the same distance ; but the two ends remained connected by a string of cellular tissue. The upper fragment of the artery was firmly plugged by red coagulum for the space of about one inch, above which the clot only partly filled the vessel ; the lower fragment was partially closed by clot, and by the remains of the middle and internal coats. A small mass of condensed cellular tissue, of cartilaginous hardness, was found lying at the inner side of the upper fragment. The vessels lower down were healthy.

Remarks as appended to the above case.—The lesion of the great vessels of the ham, which is described above, was accompanied at first by few of the symptoms that would have been expected, since, although both artery and vein were found completely interrupted, no symptoms of gangrene occurred till several days after the receipt of the injury, and no pulsation was at any time detected in the effused blood. That the vein was torn completely across at the time of the accident, hardly admits of doubt, from the appearance of the clot, which plugged its lower end, compared to that of the upper ; a contrast so decided, as to show that the two parts of the

vessel had been subject to quite different conditions from the first. But it is not so clear that the continuity of the artery was interrupted at the time, as the circulation appeared to go on for some time in the injured limb with sufficient power to produce pulsation in the tibial vessels, which could hardly have resulted merely from an indirect circulation. It suggested itself, therefore, to some of those who saw the case, that it was possible that the wound of the artery might at first not have been so extensive as it was when the limb was examined, and might have been so far occluded by the clot as to have allowed the circulation to go on; and then might have afterwards yielded under the weight of the column of blood. The powers of nature in maintaining the circulation under the most unfavourable circumstances could not be more forcibly illustrated than by this case, in which the only channel for the direct supply of blood to the leg was, at any rate, seriously injured, and the principal vein broken off, leaving no channel for the return of blood, except the internal saphena vein; and yet where mortification was delayed, until the establishment of the collateral circulation, and the deep parts retained their vitality throughout.

CASE 9.—*Complete laceration of popliteal artery; slight wound and hæmorrhage therefrom; exploration by incision; extensive extravasation; secondary hæmorrhage on fifteenth day; death.*¹

Anne Mould, was brought into Guy's Hospital intoxicated. She had been run over by a coach, the wheel having passed over the lower and back part of both her thighs. It was immediately followed by a large effusion into the ham. A small deep wound was found in the ham, from which there was free hæmorrhage, to appearance venous. The wound was dilated, but no bleeding vessel discovered; it was dressed, and a gentle pressure applied. From the swollen state of the limb, it was thought right to keep up evaporation from the surface. It was evident, for some days after the accident, that an internal hæmorrhage was going on, and the blood extravasating between the flexor muscles on the thigh. The integuments of the whole limb became distended, and the wound turned sloughy. An ichorous bloody matter issued from the wound, and the swelling of the limb was somewhat diminished. On the thirteenth day, the wound had assumed a much healthier appearance, and things seemed fair for recovery. On the fifteenth day, profuse hæmorrhage took place, and death ensued.

Preparation of lesion preserved in the St. Thomas's Museum, Section V, No. 5.

¹ Vide 'Medico-Chir. Trans.,' vol. iv, p. 448, quoted by Travers.

The right popliteal artery was completely torn across.

The femur has not been retained, but it doubtless formed the front wall of the cavity exposed in the preparation. This cavity was filled with pus and blood, is large and irregular (about the size of a goose's-egg), and its walls have a flocculent appearance. Into it is seen descending, at the upper part, about half an inch of the artery, the torn mouth of which is open, a thin fibre of adherent lymph lining the tube above; about half an inch to the left, is the lower part of the artery, about three inches in length; its torn end has the conical form common to a divided artery in process of cure, and contains a well-defined though not large clot, and a film of lymph runs down the vessel for about an inch. Upon the back of the preparation, near its middle, is the passage which led from the cavity to an external wound.

SERIES II.—*Incomplete laceration of the popliteal artery.*

The popliteal artery is very liable to incomplete rupture of one or more of its coats, such as is so frequently observed in the formation of popliteal aneurism, in many instances of which the lesion may be distinctly traced to external injury or violent exertion and straining of the knee. But it is not to this class of cases which we intend to direct our attention, inasmuch as in these there is formed a bag or sac, of a circumscribed character, which distinctly localises and confines the mischief to the seat of injury, there being no extravasation of blood into the neighbouring tissues.

The following series comprises partial lesions of all the coats of the artery, such as is produced by rupture, penetration or perforation by spiculæ of fractured bone, ulceration of the coats, &c. &c., in all of which blood becomes extravasated into the cellular tissue, diffusing itself among the muscles, without any sac or barrier being formed by the coats of the vessel, and having no characters of an aneurism, excepting that of pulsation in the swelling, and even this sign is not always present. In general, these cases are called diffused aneurisms, as may be observed in perusing the details of the cases here selected; but we prefer the more correct and intelligible definition, viz., lacerated or ruptured artery with extravasation.

The symptoms, we shall find, are very similar to those in the first series, but in a less aggravated form; for the blood is not completely cut off from the limb below, as the tube has not entirely undergone solution of continuity, but is still able to allow sufficient blood to maintain circulation in the foot and

toes. John Bell, in his remarks appended to a case of ruptured femoral artery in the middle of the thigh, makes the following comment upon the lesion; and we here introduce it, as bearing most appositely to that of partial rupture of the popliteal artery, where the progress has been slow and gradual, as was more especially observed in Cases 12, 17, 19, 21A, 21B, and 27. He says: "I desire you to observe, 1st, how well this great artery is supported by its cellular substance, and how slowly it overcomes the resistance of its own sheath; for had this been a natural aneurism, dilating slowly for a year, and bursting then by mere extension, the appearance on dissection would have been very singular.

"2d. You will remark how, when the sheath bursts, and the closer cellular substance which immediately surrounds the artery is torn, the blood, escaping among the muscles, tears the cellular substance in the interstices of the muscles from time to time, with successive lacerations and successive injections of blood.

"3d. How the limb is supported by the main artery, while its sheath continues firm, and while the blood is confined to its natural channel. And here I must also remind you, that this case is an additional proof of the limb surviving the total bursting of the artery, supported by the inosculating arteries, not only against this loss of its main artery, but also in spite of the effusion of the extravasated blood injected among the muscles, and swelling up the whole limb, and oppressing it to such a degree as entirely to prevent the pulse of the aneurism.

"And yet there may be a sort of misgiving in your mind that this was not a bursting of the artery; that the strain caused some injury, which injury might bring on disease and dilatation of the vessel; while the sense of inward lacerations in the last days of this man's life might be nothing more than the giving way of the vessel thus dilated. But I will remove all such doubts, by demonstrating to you that the artery is actually ruptured by the strain, and that the progress of the disease, the time of its enlargement, or the degree of extravasation depend altogether on the manner in which the artery is ruptured, or on the exertion of the limb; for it is the occasional exertion that causes those inward hæmorrhages by which the aneurism is from time to time enlarged."

We have collected together nineteen cases, and perhaps many more might have been added from the foreign journals or works, but these will be sufficient for our purpose.

With regard to the *causes* mentioned in these Cases :

In Case 10 it was attributed to the exertion of walking; Case 12, to a severe fall whilst in a state of intoxication, but on dissecting the state of the limb on the thirty-ninth day, it is questionable whether the rupture was not due to partial dislocation of the knee, similar to the cases of the foregoing series; Case 14 to a blow on the ham from jumping over an iron gate; in Case 19, to a hurt of the knee; in Case 15, the foot slipped off a spade as he was digging, and his heel came forcibly to the ground; Case 16, violently striking the knee against a door to force it in; Case 17, whilst working in breaking up rafters, his leg became locked in between two logs of wood, and he made violent efforts to disengage himself, causing forcible extension of limb; Case 18, jumping up ascent, with knee tense, from the bottom of a ditch to the edge; in Case 21B, a lamplighter slipped from off a board, his right leg passing between two other boards as far as the ham; Cases 11, 13, 20, and 21A, no assignable cause is given, and it is difficult to say whether the mischief had a spontaneous origin or not; in Cases 22 and 23, the injury was produced by fractured bones, the femur and tibia respectively; in Cases 24, 25, and 26, the artery was perforated by a sequestrum of bone; in Case 27, Mr. Travers attributed it to ulceration of the artery, but this is questionable.

Symptoms.—In many of the cases the actual rupture of the artery was not at first recognised, the lesion having been generally followed by slow and insidious changes, and it was not until a sudden or fresh outburst ensued, that attention was directed to the condition of affairs; in others, however, it was at once manifest. The symptoms will be best detailed by referring to the several points in each individual case, as adopted in the first series.

The latent or premonitory symptoms of a ruptured vessel before its final development—the primary complaint noticed in 11 cases.

Case 10, for two weeks complained of a sensation of numbness in the lower part of the calf, and in a few days the foot and ankle swelled, and gradually extended up the leg.

Case 12, had experienced slight stiffness in the leg, which subsequently increased, and was attended with pain.

Case 13, flying pains in the joints for three weeks, which ultimately settled in the knee, and the leg swelled, confining him to bed.

Case 17, immediately after the injury, he had great pain, and fell down.

Case 18, experienced sharp pain at the time of the accident, which made him fall back, but the pain subsided.

Case 19, the injury upon and about the knee was followed by cramp and lameness, and in six weeks inability to walk on account of excessive cramps.

Case 21A, for five months had frequent pains in ankle and foot, and ankle began to swell without any assignable cause; this was supposed to be rheumatic. The swelling increased up the leg, and the pain continued.

Case 27, after mowing grass with unsound shoes, foot and leg began to swell and inflame, and shortly after a number of red spots appeared in the leg, and in five days the inflammation reached the thigh.

In Cases 24, 25, 26, there was diseased bone, sinuses, and hæmorrhage through the latter at intervals.

1. *Sensation of something having given way, and sensation of swelling, &c., &c., only observed in 4 cases :*

Case 27, although premonitory symptoms, whilst sitting in a chair before the fire, he felt something give way, and had a trickling sensation down the thigh; suddenly turned pale, and fainted.

Case 13, had all symptoms of rupture, and attempt at repair by formation of coagulum, when, on fourteenth day, he felt a sudden snap attended with aggravation of all former symptoms.

Case 22, complained of constant sensation of swelling of thigh and calf of leg, attended with acute pain in the foot.

Case 25, while dancing at a wedding, felt sudden uneasiness in the thigh, and hæmorrhage took place through the fistulous openings.

2. *The swelling and tumefaction of the ham, leg, &c., observed in all the cases, excepting Cases 25 and 26, where sinuses existed which permitted the effused blood to pass out externally, and thus prevented further extravasation.*

a. It was sudden in 6 cases.

In Case 10, this took place three weeks before admission, and afterwards it steadily increased; in Case 14, after attempts at repair of the rupture, on the fourteenth day, sudden enlargement and tense condition of the limb; in Case 19, there was immediate swelling of the calf of the leg, which remained stationary for three months, when the swelling began to enlarge, and remained thus for another seven months; in Case 22, sudden swelling of ham on fifth day after fracture of the thigh; in Case 23, sudden enlargement and tension, increasing rapidly, and extending above the knee and down to the ankle; in Case 24, there was a sudden filling up of the ham.

b. Although not sudden, yet a rapid increase of size of limb in 5 cases.

Case 11, there was a swelling in the ham for three weeks, which rapidly increased, and continued to do so, enlarging the size and circumference of the limb; in Case 13, the whole limb, from the trochanter to the toes, was enormously distended,

and swollen to nearly double the size of the other; in Case 15, the leg at first swelled, and he continued work for a few days, when the swelling increased and soon formed a large tumour; in Case 16, the blood was extravasated with sufficient promptitude as to form, in the space of eight days, a tumour which filled the ham; in Case 18, on the day following the accident, the tumour, which had already become large, increased rapidly.

c. The swelling was gradual and slow in 5 cases.

In Case 12, during five weeks before admission; in Case 17, daily increase for five weeks; in Case 21A, the swelling commenced at the ankle and extended up the leg, and at the end of three months the parts at the back of the knee began to swell; in a few days the whole knee became enlarged, and at the fifth month the knee became uniformly swollen, and nearly half as large as the other; in Case 27, the swelling also began from below the leg and ankle, and extended upwards, reaching the thigh, which became enormously large; the swelling increased from day to day; in Case 21B, a small swelling appeared two weeks after the accident, which increased for some weeks, and attained a large size at end of two months.

3. Condition of the skin covering the swelling, and character of the tumour.

Case 10, very tense, red and inflamed, supposed to be erysipelas, and treated accordingly previous to admission. Most of the effused blood appeared to be in a fluid state, as by pressure the size of it might be reduced and when, by removal thereof, it instantly refilled. The tumour increased in size, became more distended and tense; commencing below the knee, extending along the whole calf, encircling the knee.

Case 12, swelling became hot and hard, and gave the sensation of a diffused fluid; on the outer side of the ham there was a fluctuating spot under the integument, which was somewhat discoloured, and into which an exploring needle had been passed, previous to admission, and some blood evacuated.

Case 13, integuments generally white, but about knee and ham red; the whole thigh, particularly the lower part, was very tense and hard; below the ham the swelling was not so tight, though considerable; remained much the same for fourteen days, when sudden snap, and tumor became suddenly more tense.

Case 15, considerable ecchymosis extending up the inside of the thigh; much general swelling, which prevented the boundaries being distinguished. There was considerable effusion into the knee-joint.

Case 17, calf of leg raised and tense.

Case 19, whole leg exceedingly tense; not the least visible discoloration of the integuments.

Case 21A, the ham hard, skin very tense, of natural colour over anterior and lateral parts, but of a dark-livid and almost black patches in ham. Swelling elastic to the touch, and sense of fluctuation, extending four to five inches above the knee. After being in hospital two months, the ham was still as large as ever, and prominent; the skin exceedingly tense and firm, but of natural colour. A superficial ulcer, of the size of a shilling, appeared on the outer ankle, and dis-

charged freely. A week after this, a vesicle appeared in the ham, which burst and discharged a clear fluid; and at the end of another week, a small fluctuating swelling was perceived at the under part of the tumour, which was opened and gave exit to a small quantity of bloody fluid.

Case 21B, no discoloration at time; at end of six weeks, much tension.

Case 22, ecchymosis in ham.

Case 23, distended, and integuments assumed a dark livid colour, and vesications observed about the leg.

Cases 24, 25, and 26, fistulous openings about knee, leading to diseased bone, the first only attended with swelling in the ham.

Case 27, There was a large swelling occupying lower three fifths of thigh, extending into ham; although circumscribed, it was most considerable on the inner side. Tumour was elastic on pressure, but no fluctuation could be detected; the integuments were very much discoloured, of a livid colour, and at the upper and inner part of the swelling, there were two small openings discharging a sanious fluid.

4. *Pulsation of the swelling in the ham.*—This symptom is generally present in cases of partial rupture, and thus differs in one essential feature from that of complete rupture; it materially assists the surgeon in his diagnosis and mode of treatment. Here the main vessel is still pervious to the current of blood, part escaping through the lacerated opening in the artery into the ham, and part continuing its course through the lower end of the trunk; there is no coagulum blocking up the vessel, and at each beat of the pulse an impulse is communicated to the extravasated blood in the swollen limb, causing pulsation to be felt and a bruit or whiz to be audible.

In analysing the 19 cases brought under notice, in 6 this circumstance is not recorded, viz., Cases 11, 14, 18, 20, 25, and 26, but in all probability pulsation was detected, inasmuch as they were called aneurisms. Of the remaining 13 cases this particular symptom was carefully attended to; in only 3 instances was there an absence of pulsation, viz., in Cases 19, 21A, and 27, and in all the rest more or less pulsation was evident and distinct; thus—

Case 10. Pulsation, synchronous with the arteries, plainly perceptible over the middle of tumour in ham, but not nearly so distinct at the sides; on following day pulsation less evident.

Case 12. Tumour gave a distinct but feeble pulsation over whole surface; a slight bellows-murmur heard; pressure on femoral arrested the pulsation.

Case 13. Pulsation evident to the touch; distinct thrill, somewhat bellows-like

when ear applied over rectus muscle; tumour became less pulsatile, as coagula appeared to be forming.

Case 15. Large, pulsating tumour in ham; a dull sound was heard in the tumour, but no genuine aneurismal bruit.

Case 16. The pulsations raised the hand with the greatest force, but nowhere could the part be felt indicating the site of the rupture.

Case 17. On applying the hand over the femur there was a general thrilling sensation, and a peculiar whiz on the external side.

Case 21B. At first strong pulsation; afterwards a confused pulsation.

Case 22. A diffused pulsation in the ham, but absence thereof in *tibials*.

Case 23. Distinct, although slight, pulsation could be felt in the ham; *tibials* pulsated.

Case 24. Pulsation quite distinct, and bruit de soufflet audible for some distance around it, as if from aneurism; the pulsation of the artery below the tumour in the ham was distinctly perceptible.

Case 27. The thigh became enormously swollen and beat very quickly, but after three or four days the pulsation ceased; there was no pulsation in the swelling in ham.

In Cases 19, 21A, and 27, where there was no pulsation, the lesion existed five months, much effusion had taken place, and the parts rendered tense and hard.

The pulsations in the tibial vessels were only paid attention to in two cases; in one, Case 23, it was present, and in one, Case 22, it was absent.

5. The presence or absence of pain.

It was attended with considerable pain in Cases 10, 11, 12, 15, 17, and 18; and with excessive pain in Case 19, which, however, subsided; it was intense in Case 24. In Case 13 there was little or no pain until a fresh and sudden snap in ham, when it became very great. In Case 21A there was a dull, aching pain, which was constant, and at times excruciating. In Case 21B there was considerable pain, which increased, and afterwards caused great misery. In Case 22 there was acute pain in the foot, extending to the ham and thigh.

In Case 27 not much pain was complained of.

Pain was probably present in the other cases, 14, 16, 20, 23, 25, and 26, but no record was made of the fact.

6. Sensation in the limb, only stated in 2 cases.

In Case 10 it was imperfect; and in Case 21A loss of sensation, from the knee downwards, for the last month.

7. Temperature of the limb, observed in 4 cases; it was in all probability natural in the other cases.

In Cases 10 and 23 the leg and foot became cold, in Case 15 the toes were said to be not cold, and in Case 17 there was no great heat or sensibility in the limb.

8. *Œdematous condition of the limb*, only noticed in 6 cases.

Case 10. The lower part of the leg and foot were very œdematous.

Case 11. Severe œdema of limb, which increased.

Case 13. Ankle œdematous, which greatly diminished on third day.

Case 16. Œdematous condition of limb.

Case 21A. Leg and foot œdematous.

Case 27. Foot and leg swollen and œdematous, with desquamation of cuticle.

9. *Position of the limb* is not materially affected, as evinced by the few cases in which it was observed.

Case 10. Limb in bent position, and much pain on the least attempt to move it.

Case 18. Could scarcely move the limb, in consequence of swelling and pain.

Case 21A. At third month the parts at the back of the knee began to contract, preventing the straightening of the leg; the leg became flexed and fixed.

10. *Gangrene* supervened in 8 cases.

In one, Case 24, it followed as a natural sequence to large extravasation from a wounded artery; and in another, Case 23, gangrene was threatening. In both these cases amputation was proposed, but refused.

In 7 cases it supervened after ligature of the femoral had been effected, viz., Cases 10, 11, 12, 16, 23, and 25, who ultimately died, and Case 14, who recovered.

11. *External hæmorrhage and secondary hæmorrhage*, noticed in 5 of the cases.

Case 21A. Incision made into fluctuating part of swelling, followed by hæmorrhage, and checked by pressure; in three days very copious secondary hæmorrhage supervened, and again recurred in the space of another three days, when fatal syncope ensued.

Case 27. Two small openings formed in the skin, and about a pint of dark-coloured fluid escaped from one of the openings.

In Cases 24, 25, and 26, hæmorrhage through old-standing fistulous openings.

Case 24 some time back had a very alarming hæmorrhage from one of the openings, but no recurrence until night before admission, when he bled with great violence; the blood, at intervals, spirting out to a considerable distance, at other times trickling down the limb, but in neither case was he able to restrain it. He supposed that he lost several quarts of blood, and fainted from exhaustion seven or eight times. Bleeding occurred during the night of admission and on the following day, and amputation refused. Death.

In Case 25 sudden bleeding took place through two fistulous openings, and continued, more or less, for eight days, notwithstanding compression.

In Case 26 recurrence of bleeding at frequent and long intervals.

12. *The progress and results* which ensue when these cases are left alone, from the refusal of the patient to undergo operation, are well exemplified in Cases 21A and 24.

The DIAGNOSIS in these instances was comparatively easy, for in 11 of the 19 cases pulsation in the swelling was readily detected, and in 6 others, although the actual condition was not stated, yet the disease was called aneurism, as indicating the essential characters thereof. In the remaining 2, arterial hæmorrhage escaped through the sinus, and at once showed the nature of the mischief.

In Cases 19, 21A, 21B, and 27, there was some difficulty in the diagnosis, owing to the absence of pulsation, but which could be readily cleared up by careful attention to the previous history of each; thus, in Case 19 it was presumed to be aneurism from the deepness of the swelling, the sudden enlargement, and the violence of the pain; in Case 21A it was questionable as to whether the disease was not an abscess or fungoid disease; in Case 21B, on account of the tension and confused pulsation, the disease could not well be ascertained; and in Case 27, although the history pointed out the true nature of the lesion, yet the absence of all pulsation in the swelling rendered the diagnosis unsatisfactory, and to the employment of an exploratory incision.

PROGNOSIS of 19 cases—10 recovered, and 9 died.

Limb and life saved in 6 cases; 4 by ligature of femoral, and 2 by ligature above and below rupture.

Limb lost by amputation, and life saved—4 cases.

Life lost in 9 cases, 2 refused operative measures, 1 after amputation, 6 after ligature of artery and subsequent gangrene.

THE EXAMINATION OF THE LIMB and actual condition of the lesions induced, where a dissection of the parts had been permitted, are fully detailed in the report of cases, and do not require further analysis.

TREATMENT of partial rupture of the popliteal artery.—In the majority of these cases the lesion had taken place without much damage to the surrounding tissues or to the knee-joint, so that it had not been attended with such excessive violence as witnessed in complete rupture. Hence we ought to expect less mischief ensuing, and to entertain hopes of saving the

limb; but can we do so without operative measures? Cases 21A and 24, which were left alone, owing to the refusal, on the part of the patients, to undergo operation, tell us no; a perusal of their cases will at once satisfy us on this point, one of them dying from secondary hæmorrhage, and the other succumbing to secondary hæmorrhage and gangrene.

The remedies resorted to were the following:

1. *Compression of the femoral artery* was tried in only one case (14), but could not be borne. We should certainly feel disposed to recommend this line of treatment in all cases of partial rupture, where there is no great amount of distension interfering with the collateral circulation.

Direct compression on the seat of rupture is useless; the depth of the artery, and inability to compress it without excessive force and injury to the vein and nerve, preclude its performance. It was attempted in Cases 24 and 25 without effect, and in Case 18 it could not be borne.

2. *Ligature of the femoral artery*, as a substitute for compression when the latter fails.—Ligature was performed in 9 cases, in 4 of which it was successful, and in 5 gangrene supervened and death resulted. The following table will explain all details.

Cases.	Date of operation.	Ligature came away.	Effects.	Results.
10	5th week.	21st day.	Gangrene, attempts at separation.	Death 4 weeks after operation.
11	3d „	—	Gangrene.	Death 43 days after.
12	6th „	17th day.	ditto.	Death 39 „
23	30 hours.	—	ditto.	Death on 8th day.
25	8th day.	—	Rapid gangrene.	Speedy death.
13	3 weeks.	17th day.	Fever, diarrhœa, and pneumonia.	Recovery.
14	8 „	19th „	Gangrene of foot and natural separation.	ditto.
15	3 „	13th „	—	ditto.
22	5th day.	20th „	—	ditto.

3. *Incision into the ham, and a ligature above and below rupture.*—This was performed in the 4 cases quoted from M. Pelletan (Cases 16, 17, 18, and 20), and was attempted in Case 19.

In Case 16 it was had recourse to on the eighth day, but gangrene followed in thirty-six hours, and death on the sixth day. In Case 20 the ligature on the vessel was insecurely applied, the knot slipped, secondary hæmorrhage supervened, and amputation had to be performed, but death resulted. In Case 18 the operation was performed several days after the rupture; suppuration took place, and recovery at the end of three months. In Case 17 the ligatures were applied on the sixth week; the lower one came away on the nineteenth day, and the upper one on the day following; recovery took place at the end of six months. In Case 19, upon opening the tumour, the coagulated blood appeared to have acquired a fleshy consistence, and adhered very firmly one portion to another; the ruptured artery appeared just between the heads of the tibia and fibula, so that it was impracticable to tie, or at least judged inadvisable, considering the condition of the leg; therefore amputation was immediately performed.

4. *Amputation* performed in 5 cases; of these, in 2 it may be called *primary*, viz., Cases 19 and 20, in both of which unsuccessful attempts had been made to secure the artery in the ham, when it had to be resorted to; one recovered and one died.

The secondary amputations were in Cases 21B, 26, and 27, in two of which there was success, and in the other the result was not stated.

The summary of the results has been already anticipated under the head prognosis; thus, of the 19 cases, 9 died and 10 recovered.

Of the 9 deaths, 2 refused any operation, 5 died of gangrene after ligature of the femoral artery, 1 of gangrene after ligature at seat of rupture, and 1 after primary amputation, in consequence of secondary hæmorrhage.

Of the 10 recoveries, 4 after ligature of the femoral, 2 after ligature at the seat of rupture, and 4 after amputation, of which 3 were secondary and 1 primary.

CASES OF PARTIAL RUPTURE OF THE POPLITEAL ARTERY.

CASE 10.—*Ruptured popliteal artery; ligature of femoral; gangrene; death of the patient.*¹

George Charles, æt. 49, admitted into Guy's Hospital, on November 10th, 1830, under Mr. Key, for a large, diffused, aneurismal tumour in the calf of the right leg. All that could be learnt was that, while walking one afternoon, about five weeks

¹ 'Medical Gazette,' vol. viii, p. 635.

before his admission, he felt, for the first time, pain and a sensation of numbness in the lower part of the calf; in a few days he perceived the foot and ankle to be swollen, which gradually increased and extended up the leg; this, however, was not sufficient to prevent his walking as usual, until three weeks before admission, when he was conscious of a sudden increase in the swelling, and particularly about the calf; since then he has been unable to walk, and has suffered considerable pain. He consulted a practitioner, who, from the swollen and inflamed state of the limb, overlooked the aneurism, and supposed the disease to be erysipelas. Leeches in abundance were applied to the lower part of the leg, and purgative medicines given freely; by these means the inflammation was much reduced, as was also the man's general health. He had two or three rigors, and suppuration was anticipated.

On admission, the tumour appeared to be of a very large size, commencing immediately below the knee, extending along the whole calf, and nearly encircling the limb; it was very tense, and the integuments red and inflamed; most of the supposed effused blood appeared to be in a fluid state, as by pressure the size of it might be much reduced, and when removed it instantly refilled; a pulsation, synchronous with the arteries, was plainly perceptible over the middle of it, but not nearly so distinct at the sides. The lower part of the leg and foot were very œdematous, and sensation imperfect. He was unable to bear upon the leg, but lies with it in a bent position, and complains of much pain on the least attempt to move it. His strength was much reduced, and he appeared in ill health. There was no aneurismal thrill about the pulse, which was feeble and rather quick. Cold lotion was ordered to the tumour, but as the leg and foot soon became cold, warm flannels were applied to the foot.

On the following day the tumour had increased in size, was more distended and tense, and pulsation less evident. A ligature was placed on the lower part of the femoral artery previous to entering the opening formed by the triceps tendon. Immediately upon the vessel being secured, the tenseness of the tumour was much diminished, and not the slightest pulsation could be felt, but in the evening the distension had rather increased.

On the third and fourth days the foot and leg continued warm, but symptoms of constitutional irritation set in, and on the fifth day signs of gangrene showed themselves. Mr. Key wished to amputate, but Sir A. Cooper, considering the livid appearance arose rather from obstruction to the cutaneous circulation than from incipient gangrene, wished gentle friction to be used; and even should mortification ensue, Sir A. Cooper thought amputation had better not be performed, hoping it would not extend beyond the calf, and thus, perhaps, the knee-joint might be saved. The ligature came away on the twenty-first day.

Gangrene extended slowly up to near the calf of the leg, suppuration ensued, and nature endeavoured to separate the limb, but her powers failed, and the patient succumbed at the end of the ninth week, worn out by the excessive discharge and constitutional irritation. No post-mortem allowed.

Remarks by Mr. Key.—The day following his admission a consultation was held as to the propriety of amputating the limb at once, or whether an attempt should be made to save the limb. It was a matter of considerable doubt if it were an aneurism of the lower part of the popliteal or of the posterior tibial artery; on the other hand, the situation of the

tumour seemed to point out the posterior tibial as the affected vessel, and the possibility that in this case the blood, contrary to what is usually found to take place, might have descended, inclined some rather to consider it as popliteal.

Independently of the doubt as to the affected vessel, it was considered an unfavorable case for tying the artery. In the *first* place, if the femoral artery were tied, the patient's low state, the largeness of the aneurism, and the swollen state of the limb, rendered it probable there would not be sufficient circulation to maintain the life of the leg. *Secondly*, if, instead of tying the femoral artery, the aneurism should be opened and the coagulum turned out, the difficulty there might be in securing the ruptured vessel, and if found to communicate with the posterior tibial, the deep situation of that artery, would render it extremely difficult, if not impracticable. *Thirdly*, if the affected vessel were secured, it was hardly to be expected that, reduced as the patient was, he would be able to support the immense suppuration which must necessarily ensue.

In favour of tying the femoral artery, it was said that, by passing the ligature round it as low down in the thigh as could be, just as the vessel passes through the tendon of the adductor muscle, probably the supply of blood to the tumour would be cut off, or at any rate so much lessened, and the impetus of that sent so diminished, as not to prevent the curative process being set up, while the anastomosing branches would be sufficient to maintain a due circulation in the limb; the absorbents might then possibly remove the effused blood, and if this did not take place, the bulk of the tumour being much diminished, the consequent suppuration would not be greater than the man could bear. By adopting this plan the only chance of saving the limb would be given; and if it did not succeed, recourse could then be had to amputation.

CASE 11.—*Ruptured popliteal artery; ligature of femoral three weeks after; gangrene; death forty-three days after operation.*¹

N. D—, æt. 52, habitually intemperate, and readily excited; admitted into Marylebone Infirmary, under Mr. B. Phillips, with a diffused popliteal aneurism on the

¹ 'Med. Gaz.,' vol. xxxi, p. 377.

right side, which had already produced some œdema of the right foot. His account of it was, that he had discovered a swelling in the ham three weeks before admission; that it had rapidly increased in size, and become very painful, especially at night. There was so much general irritability and arterial action, that it was thought advisable to delay operative measures for a few days. However, the pain in the ham increased, as also the size and circumference of the limb; and it was resolved to operate forthwith, but no persuasion could move him to submit. Several days passed on, the pain increased, the size of the limb also, as well as the œdema, and he then himself proposed operative measures. Ligature of the femoral was performed, and two other large arterial trunks, seen in the course of the operation, likewise ligatured.

The patient's suffering was lessened from the moment of the operation; the pain in the tumour was dissipated, and in forty-three hours his general condition and countenance improved; but one thing created uneasiness, and that was the large quantity of blood effused at the ham and at the upper part of the calf. On the eighth day there was heat and redness, and on the eleventh fluctuation was evident; this was explored; a dark, thin, red, bloody fluid escaped, containing pus. Two incisions were made, to allow of escape of fluid, but not much evacuated. Gangrene set in. Death on forty-third day after operation.

No facilities afforded in examining limb. The parts were so broken down by gangrene that nothing could be made of them.

CASE 12.—*Ruptured artery; ligature of femoral on sixth week; gangrene. Death thirty-nine days after operation.*¹

Thomas C—, æt. 56, tailor; pale; unhealthy; admitted into the Liverpool Royal Infirmary, under Mr. Stubbs. About five weeks before admission, while drunk, met with a severe fall. For some time previous to this occurrence he had experienced slight stiffness in the left leg, which subsequently increased, and was soon attended with pain. After the accident he soon perceived a swelling behind the knee, which became hot and hard, and caused pain on walking; it had gradually increased in size.

On admission, there was a swelling in the left calf, giving the sensation of diffused fluid; a tumour of considerable size occupied the inner side of knee, and extended into popliteal space, and gave distinct but feeble pulsation over whole surface; a slight bellows-sound heard. The veins crossing it were large. Pressure on femoral arrested the pulsation. On the outer side of the ham there was a fluctuating spot under the integument, which was somewhat discoloured, into which an exploring needle had been passed previous to admission, and some blood evacuated.

Ligature of the femoral performed on the eighth day. Favorable progression until tenth day, when gangrene attacked fourth and fifth toes. The ligature came away on seventeenth day, and an incision was made into the ham, and a large quantity of coagulated blood removed, and with relief. Gangrene continued to progress, and amputation unable to be performed on account of patient's condition. Death resulted on thirty-ninth day.

¹ 'Med. Times,' vol. xxxi, p. 60.

Examination of limb.—No aneurismal sac could be discovered. The structures in the ham had all sloughed to a considerable extent. The popliteal artery was traced down to opposite the knee-joint, and at that point it was destroyed; the same remark applies to the vein; the internal and external popliteal nerves were to a great extent destroyed. The knee-joint was opened from behind. The arteries of the limb were the seat of extensive atheromatous deposit.

CASE 13.—*Rupture of artery; ligature of femoral at fifth week; pneumonia. Recovery.*¹

W. Warren, æt. 36, carman; admitted into London Hospital, under Mr. Scott. Perceived flying pains in the joint three weeks ago, which ultimately settled in the left knee; the leg swelled and confined him to bed. On admission, the whole left limb, from the trochanter to the toes, was enormously swollen, and nearly double the size of the other; the integuments generally white, but about the knees, and in the ham especially, they are red; the whole thigh, particularly the lower part, where there is a strong pulsation, was very tense and hard; below the knee the swelling is not so tight, though considerable; the ankle œdematous; little or no pain, except on motion. He had an attack of double pneumonia, and was bled; had calomel and opium and colchicum. On the third day the œdema had greatly diminished; the tumour much the same; pulsation evident to the touch; a distinct thrill, somewhat bellows-like, when the ear is applied over the lower part of the rectus.

On the fifth day tumour harder, less pulsatile; coagula appear to be forming; pneumonia still in the lower part of the left lung.

On the fourteenth day, feeling a sudden snap in the ham this afternoon, attended with great pain, and the tumour becoming suddenly tense, the femoral artery was secured by a double ligature at the usual spot.

Fever and diarrhœa supervened, which subsided, as also the pneumonia.

Ligature came away on seventeenth day. Slow recovery.

CASE 14.—*Ruptured artery; six weeks after, compression tried; ligature of femoral. Recovery.*²

A man, æt. 30, was admitted into King's College on account of a large popliteal aneurism. The tumour had followed a blow on the part, inflicted six weeks before admission, in jumping an iron gate.

Treatment by compression was tried, but could not be borne. During the fortnight the man was in the hospital before the operation, the aneurism became diffused, and double in size.

Ligature of the superficial femoral performed. Four days after, mortification of foot began. A line of demarcation afterwards formed about the ankle, and separation is now proceeding.

The ligature came away on nineteenth day, and the wound healed well.

¹ 'Med. Gazette,' vol. xiv, p. 460.

² 'Med. Times and Gazette,' 1856.

CASE 15.—*Ruptured artery; a few days after, ligature of femoral. Recovery.*¹

J. W—, æt. 30, admitted into St. George's Hospital, under Mr. Pollock; agricultural labourer, in good health. Three weeks before admission his right foot slipped off spade as he was digging, and his heel came forcibly to the ground; two hours after, he noticed that the leg was swollen; next day the leg remained swollen, but was not particularly painful, and he continued his work for a few days. The increase of the swelling and the accession of pain then compelled him to take to his bed.

On admission, there was a large, pulsating tumour in the ham, and considerable ecchymosis, extending up the inside of the thigh; there was much general swelling, which prevented the boundaries of the pulsating tumour being distinguished. A dull sound was heard in the tumour, but no genuine aneurismal bruit. There was considerable effusion into the knee-joint. The toes were not cold.

Ligature of femoral immediately performed. Ligature came away on thirteenth day. Recovery.

CASE 16.—*Ruptured artery; incision into ham; ligature above and below wound; gangrene. Death.*²

A man, about thirty, well-developed, ruptured his popliteal artery in violently striking his knee against a door so as to force it in. Blood extravasated with sufficient promptitude as to form, in the space of eight days, a tumour which filled the bend of the knee, a determined swelling, and an œdematous condition of the leg. The pulsations raised the hand with the greatest force, but nowhere could the part be felt indicating the site of the rupture. In this state he was sent to the Hospital of the College of Surgery, and M. Louis, the surgeon, charged M. Pelletan to operate. A long incision was made in the ham, coagula removed, and the whole space cleared; but still he could not find the large packet of vessels, only laying bare a large cavity, in posterior part of which were observed the condyles of the femur and tibia. On turning aside the external border of the wound, the artery was immediately seen, and an oval aperture observed at its anterior aspect. Two ligatures were applied, and tied, one above and the other below the wound. Gangrene supervened in thirty-six hours. Amputation could not be performed, and death ensued on sixth day.

Dissection of the limb proved that all the arterial branches had been likewise ruptured, and comprised the superior external and internal articular arteries.

CASE 17.—*Ruptured popliteal artery; incision into ham; ligature above and below wound. Recovery.*³

J. S—, æt. 32, robust, many years a soldier; had lately had much rough employment; had never had any pain or disease in the ham. Whilst working in breaking up rafters, his right leg became locked in between two pieces of wood, and he made violent efforts to disengage himself. He immediately experienced great pain, and

¹ 'British Med. Journal,' 1857.

² M. Pelletan, in his work on 'Clinical Surgery.'

³ Ibid.

fell down. He soon felt a lump in the ham, of the size of a nut; this daily increased, as well as the pain in proportion, and six weeks after this, was admitted into the hospital. He was then suffering great pain; the calf of the leg was raised and tense, and there was great heat and sensibility in the limb. On applying the hand over the ham there was a general thrilling sensation, and a peculiar rôle, on the external side.

A long incision, ten inches in extent, was made in the popliteal space, and a ligature applied above and below the wound in the artery. Suppuration ensued. The lower ligature came away on the nineteenth day, and the upper one on the day following. Recovery at the end of six months.

CASE 18.—*Ruptured artery; incision into ham; ligature above and below wound. Recovery.*

M. L—, a violinist, an active, vigorous young man, was jumping up an ascent, with knee tense, from the bottom of a ditch on to the edge, when he experienced a sharp pain in the ham, which made him fall back. The pain soon subsided, but on the following day a tumour was discovered in the ham, which was already large, and was increasing rapidly. Compression was tried, but could not be borne. The tumour increased daily in size, so that he could scarcely move the limb in consequence of the swelling and pain.

The case required urgent and immediate operation; the ham was laid open, but there was much confusion of parts; the ruptured artery was exposed, and a ligature applied above and below. Suppuration ensued. Recovery in three months. (See Pelletan.)

CASE 19.—*Ruptured popliteal artery; slow and partial extravasation; nine months after, incision into ham; inability to secure lacerated artery; amputation. Recovery.*¹

A man, about 30 years of age, received a hurt upon and about his knee in the month of November, followed by a cramp and lameness. "In six weeks he had excessive cramps, and was unable to walk, which was followed by an immediate swelling of the calf of the leg, attended with excessive pain, and it continued in much the same state for about three months, when the pain began to increase and the swelling to enlarge. On admission, in April following, the whole leg was exceedingly tense, but there was not the least pulsation to be discovered in it, nor the least visible discoloration of the integuments. However, from the deepness of its situation, as well as from the sudden enlargement and the violence of the pain, it was presumed to be aneurism, and on that presumption the operation for aneurism was attempted on the 15th of October.

"Upon opening the tumour, the coagulated blood appeared to have acquired a fleshy consistence, and adhered very firmly one portion to another. Upon removing it totally, the tibia and fibula were found carious, and the ruptured artery appeared

¹ Warner's 'Cases in Surgery,' quoted by John Bell.

just between the heads of the tibia and fibula, so that it was impracticable to tie it, or at least judged unadvisable, considering the condition of the leg." "It was amputated above the knee upon the spot, and the patient did well."

Mr. Bell's remarks.—Here a most important fact is proved in all its circumstances. The sudden rupture of the artery, the slow growth of the tumour, the want of pulsation (which is the usual characteristic of aneurism), but, above all, the inevitable destruction of the bones, and the incurable nature of the disease! The ease with which the artery might have been tied at the first, and the necessity of amputating the limb in the end, are important lessons. We thus perceive that the very slow growth of an aneurism is perfectly compatible with the most desperate wound, or total laceration of a great artery.

CASE 20.—M. Pelletan remarks that three months previously to the above (Case 17) a case occurred in which the patient had aneurism following a ruptured artery; attempts were made to secure the vessel by ligature, but this did not succeed in arresting the hæmorrhage; amputation was performed, and death resulted. On examining the limb it was found that the ligature on the vessel had slipped, in consequence of the knot not having been firmly made.

CASE 21A.—*Ruptured artery; slow extravasation; difficulty of diagnosis; exploratory incision; secondary hæmorrhage. Death.*¹

J. L—, æt. 33, admitted into St. Thomas's Hospital, under Mr. Green; rather tall, light hair, pale, sallow, emaciated. In the silk trade. Become lately reduced in circumstances. Has led a gay, dissipated life. Always enjoyed good health.

About five months back he had frequent pains in right ankle, and foot and ankle began to swell without any assignable cause; supposed rheumatic. Swelling increased up leg, and pain continued. Three months after this the parts and back of knee began to contract, preventing the straightening of leg. Soon after this he perceived a swelling at back of knee; and, after a few days, the whole knee became much swollen, the back part being harder than the rest. Has had no shivering fits, nor has ever observed any pulsation.

On admission, the right knee uniformly swollen, nearly half as large as left; skin very tense, of natural colour over anterior and lateral parts, but in dark, livid, and almost black patches in popliteal region. Swelling elastic to touch, with a sense of fluctuation; it extends four to five inches above knee; thigh above attenuated, and smaller than opposite; leg flexed and fixed. Has lost all feeling from knee downwards for last month; leg and foot œdematous; skin thereof tense, but of natural colour; a dull,

¹ 'Lancet,' 1841.

aching pain in and about knee constant, at times excruciating. Want of rest; constitutional irritation; emaciation. Some of opinion it was fungoid, others abscess.

April 3d.—After being in hospital two months, swelling on sides of knee very considerably diminished, but back part still as large as ever, and prominent; leg has been gradually getting harder; skin exceedingly tense and firm, but of natural colour. A superficial ulcer, the size of a shilling, on outer ankle, discharging freely.

9th.—A week after this a vesicle appeared under the knee, burst, and discharged clear fluid.

16th.—At end of another week a small swelling perceived at under part of tumour; was opened; small quantity of bloody fluid escaped; hæmorrhage supervened, checked by pressure; secondary hæmorrhage three days after, very copious; a third very copious hæmorrhage three days subsequently; fatal syncope, and died on 23d of April.

On examining limb, tumour found to be a false aneurism; sac formed of the condensed surrounding tissues, and extremely thick. The artery presented a small, irregular, lacerated opening, about centre of popliteal space.

CASE 21B.—*Partial rupture of popliteal artery; subsequent circumscribed tumour; difficult diagnosis; amputation.*

(Case as related by JOHN HUNTER.¹)

John Staples, æt. 33, by trade a lamplighter, about the latter end of March, by a board giving way under him, his right leg slipped down as low as his ham between two other boards, but he did not feel any other inconvenience from the accident, not even a discoloration of the skin.

About a fortnight after, he perceived a small swelling in this ham, accompanied with a strong pulsation; the swelling increased, with considerable pain for some weeks, the last two of which he was in great misery.

Rather more than two months after the accident he came into the hospital. The whole leg was now much swollen, very painful, and there was a confused pulsation; but there was so much tension in the part, that the disease could not be well ascertained. Amputation was performed twenty-seven days after admission.

Upon examination of the parts after their removal, it plainly turned out to be a rupture of the artery, but whose orifice was extremely small; it allowed at once the blood to escape into the cellular membrane opposite to this opening, which, we may suppose, dislodged a cell or cells, and at the same time squeezed one cell against another, forming an artificial coat, which dilated from the force of the blood to the size we found it, and in the end had the common effects produced upon it that take place in an aneurism when its coats, both natural and acquired, give way, viz., the blood becoming diffused into the general cellular membrane of the surrounding parts.

On cutting into the tumour and scooping out the coagulated blood, then introducing a probe into the sound artery above, it readily passed through a small lateral opening, with rounded or smooth edges, into the cavity of the tumour. On tracing the artery downwards through this opening, I found it passing along the tumour on

¹ Hunterian MSS., 'Cases and Observations,' No. 44. See 'Catalogue of Gen. Pathol.,' vol. iii, p. 207, Royal Coll. of Surg. of England.

that side next to the bone, but obliterated nearly the whole diameter of the tumour, and become so soft and pulpy as not to be distinguishable from the other parts which were composed of coagulated blood, cellular membrane, artery, &c. In tracing the artery from below, I lost it in this mass. The crural artery, as it approached this lateral orifice for about two inches in length, became contorted or serpentine in its course, similar to what sometimes takes place in an aneurism.

Mr. Hunter's remarks.—Here was a case where there was every external appearance of an aneurism, such as a circumscribed swelling, with a pulsation.

This was what would be called or understood by a spurious aneurism; but it was probably a rupture of the coats of the artery, and which, I do imagine, is only to be distinguished from the [true] aneurism, or dilatation, by the time it takes in coming to its ultimate size, viz., from its first appearance to its threatening destruction to the parts beyond, as a limb, or destruction in the surrounding parts in which it is placed, threatening mortification and bursting. An aneurism being as many months in coming to this ultimate as this disease was days; for, in aneurism, although the artery gives way at last, and then its coats are principally composed of the condensed cellular membrane, as in this case; yet it is strong, owing to the time it has had to thicken and form a coat while the artery was dilating.

PREP. 1571. (See 'Cat. of Gen. Pathol.,' vol. iii, p. 207. Royal Coll. of Surgeons, England.)—Part of a popliteal artery, from which, in consequence of rupture of a small portion of its coats, blood escaped into the surrounding cellular tissue. A sac, with walls about a line in thickness, composed of the surrounding tissues, laminated and condensed, formed round the coagulated blood; but it is now emptied, the coagulated blood being turned downwards. A portion of whalebone is passed through the aperture in the artery into the cavity of the sac.

There is little doubt that the preparation was taken from the above case.

CASE 22.—*Fractured femur; lacerated popliteal artery; ligature of femoral; recovery.*

Richard W—, æt. 41, a stout, healthy, regular-living man, was admitted into Guy's Hospital, under Mr. B. B. Cooper, with a compound fracture of the lower third of right femur, occasioned by the kick of a horse. The fractured extremities of the bone were readily brought into apposition, and the limb was placed upon a double-inclined plane, with a splint on either side of the thigh, and a piece of lint placed over the wound.

On the fourth day he complained of a constant sensation of swelling of the thigh and calf of the leg, attended with acute pain of the foot. There was also swelling and some appearance of ecchymosis in the ham.

On the fifth day he was still restless, and complained of more pain in the ham and thigh, and particularly of the foot; and for the first time was discovered a diffused pulsation in the ham, which led me at once to the conviction of the artery having given way. On consultation with Sir A. Cooper, Messrs. Key and Morgan, it was decided that a ligature should be placed upon the femoral artery, thus giving the patient the chance of saving his limb, leaving other means to be resorted to should that operation fail.

The artery was tied at the junction of the upper with the middle third of the thigh. The tumour in the ham gradually decreased; the ligature came away on the twentieth day. On examining the limb on the twenty-eighth day, the fracture was found united. The wounds cicatrized, and the patient recovered.

*Remarks by Mr. Cooper.*¹—The patient, whose case we have related, was a healthy man; and, but for the laceration of the popliteal artery, there would have been no doubt as to a successful result of the case; for neither was the femur comminuted, nor the laceration of the soft parts sufficiently extensive to render amputation necessary; the only point, therefore, left for consideration was, how to obviate the ill effects of the rupture of so large a vessel; for, from the quantity of blood diffused, and the absence of any pulsation either of the anterior or posterior tibial branches, it was clearly the popliteal artery which had given away. Having determined not to amputate, the only plan to be adopted was evidently to secure the bleeding vessel; but this involves two questions—*first*, as to the situation in which the vessel is to be tied; and, *secondly*, when tied, whether the reparation of the femur could, under such circumstances, be expected, and, if so, by what means the blood would be conveyed.

With respect to securing the vessel, the surgeon would be guided in such a case by the situation of the external wound; for, had the wound in this case been in such a situation as to admit the escape of the diffused blood, I consider the case would have been entirely altered, and that the limb must have been amputated, or else the wounded artery tied above and below the opening, which in the popliteal space could hardly be accomplished; but as the blood did not escape, the coagulum was capable of forming so firm a compression upon

¹ B. B. Cooper's 'Essays,' p. 79.

the wounded vessel, that upon the application of a ligature above there was no fear of the recurrence of the hæmorrhage; while, on the contrary, if the blood had escaped through an external opening, and the femoral artery had been tied, the collateral branches which convey the blood to the arteries below the rupture would almost certainly have induced a hæmorrhage from the lower part of the wounded vessel. Hence in compound fracture, with a laceration of vessel, it is a great point of consideration whether the external wound does or does not communicate with the wound of the artery; and, speaking generally, it may be said that the former will require amputation, while the latter will preclude the necessity.

In reference to the means by which blood would be conveyed to the femur itself, the anatomist will at once understand, so far from there being any danger of the supply of blood being cut off by this operation, that, through the profunda branch, even a greater quantity would be conveyed to the interior of the bone; and, indeed, I may say in this case, the rapidity of the reparation, and the perfect solidity of the bone, equally proved this fact. During the progress of ossific union, the limb was allowed to lie upon the outer side, and in the semiflexed position, nor were splints applied until the wound in the thigh was entirely healed. (B. B. Cooper's 'Essays,' p. 79, *et seq.*)

CASE 23.—*Probable injury of popliteal artery by fractured portion of tibia; threatening gangrene; amputation refused; ligature of femoral on 2d day; gangrene; death.*

Wm. B—, æt. 60, admitted into Guy's Hospital with fractured leg; a strong, powerful man, and accustomed to drink a good deal of ale. While getting down from the hind part of a stage coach, he put his foot upon the wheel, and fell backwards, with his right leg under him. He was brought to the hospital about one hour afterwards. On examining the right leg, both bones were found broken a little below the knee; there was a very oblique fracture of the head of the tibia, which appeared to extend into the joint; the upper fracture projected inwards and backwards, and the lower portion upwards and outwards. The leg was tense and enlarged, there being considerable swelling and effusion; the foot was cold (probably owing to exposure), and he complained of great pain. In about one hour afterwards the distension had increased very rapidly, extending above the knee down to the ankle; distinct, although slight, pulsations could be felt in the ham; both anterior and posterior tibial arteries could be felt—the anterior more so than the other. It was inferred that the lower part of the popliteal artery was wounded.

Immediate amputation was proposed, but the man and his friends would not consent.

On the following day the limb was still more distended, pulsations not so distinct, foot warm, sensation perfect; the integuments of a dark livid colour, and vesication about the limb. Amputation again proposed and refused. Ligature of the femoral was permitted and performed; some little difficulty occurred, owing to the depth of the artery, its cessation of pulsation, and the presence of a plexus of veins covering the artery. The artery itself was much diseased. Gangrene soon became evident, and he sank exhausted eight days after ligature.

Examination of limb very imperfectly performed, in consequence of interference of friends. The popliteal, anterior, and posterior tibials, and peroneal, examined without discovering any lesion thereof. The hæmorrhage was supposed to have arisen from some smaller arterial branches; and could a more minute examination have been obtained, its source might have been ascertained. The femoral artery, at the seat of ligature, had a considerable quantity of earthy deposit between its coats. This did not appear to have been a serious objection against the ligature, as in this instance the artery was rendered impervious by its sides being glued together by coagulating lymph, as firmly as usually takes place in the same time when the vessel is quite healthy.—*PRÆP.* 1515⁶⁰.

CASE 24.—*Necrosis of femur; wounded artery; extravasation of blood; operation refused; secondary hæmorrhage and gangrene; death.*¹

John Jackson, æt. 29, of delicate habits, hard drinker. Admitted into Meath Hospital under Dr. Porter. He stated that several years previously (perhaps fourteen or fifteen) he had been seized with violent pains in the left knee, which, as well as the lower part of the right, shortly afterwards swelled to a great size, but without redness. This tumefaction subsided a little under the use of blisters, but this knee always remained larger than that of the opposite limb. About one year afterwards a small swelling appeared, four or five inches above the knee, on the inside, which he opened himself, and gave exit to some purulent matter; a fistulous opening has remained there, discharging, ever since. In August, 1832, he had a very alarming hæmorrhage from this fistulous opening; but there was no recurrence until the night before his admission, when he bled with great violence; the blood, at intervals, spirting forth to a considerable distance, at others, trickling down the limb, but in neither case was he able to restrain it. He supposed himself to have lost several quarts, and fainted from exhaustion seven or eight times.

On admission, face blanched, and expressive of greatest anxiety; extreme exhaustion, thirst; pulse small, thrilling, 150. There was a small, livid, fistulous opening on outer side of lower third of right thigh, slowly discharging a thin, serous blood, on pressing which the finger seemed to sink into a deep cavity. Pulsation was quite distinct, and bruit de souffle audible for some distance around it, as if from aneurism. The femur, at its lower third, could be felt enlarged, and the popliteal space filled up, but the pulsation of the artery below it was distinctly perceptible. He complained of intense pain in the knee, and throughout the tumour. He was too weak to make further examination.

¹ Dr. Porter, 'Dublin Journal,' vol. v.

From all these circumstances it was conceived that the case was one of popliteal aneurism, complicated with diseased bone; the sac having probably burst into the cavity of an abscess in connexion with the bone. A compress of lint was placed over the opening, and a bandage rolled from the foot, over and above it. Some bleeding occurred during the night, and next day he was seized with severe vomiting.

On the third day there was intense pain in the thigh; the face was bleached with a yellowish tinge, and extreme anxiety. Amputation was obstinately refused by the patient. The vomiting continued. The debility increased; and on the fifth day there was great swelling of the thigh, with gangrene on its posterior surface, nearly as high as the buttock. A constant though feeble hæmorrhage trickled from the limb, and he died in the evening.

Examination of limb.—Popliteal space was found filled with thick grumous clots, extending as high as the lower third of femur, in contact anteriorly with the bone, and with something that appeared to be part of the sac, but whether of an aneurismal sac, or the cyst of a former abscess, could not be determined. An opening existed in the popliteal artery, a little below the spot where it enters the space. The femur was found diseased in its lower half, being considerably enlarged, its surface rough, and a large portion of the posterior or popliteal aspect destroyed, so as to permit the introduction of the fingers into a large cavity within; the edges of the bone on each side of this opening were thick and very full of rough, sharp points; in the upper part of the excavation, the sharp point of a sequestrum was discovered, moveable and accurately corresponding to the aperture in the artery, which it evidently seemed to have occasioned. The cellular tissue of the entire thigh was filled with a reddish serum.

CASE 25.—*Diffused false aneurism of popliteal artery, from wound by sequestrum of bone; operation; death.*¹

A young man, æt. 25, who had laboured under necrosis of the lower third of right femur for some years, and in whom two fistulous openings discharged moderately, one on each side of the thigh, a little above the joint, was induced to dance at a wedding; in the midst of the glee he felt sudden uneasiness in the thigh, and bleeding took place from each fistulous opening. Some compression was resorted to, but more or less hæmorrhage occurred for eight days, when he was received into the hospital, under the care of Dr. Byron. Finding that compression on the femoral artery arrested the bleeding, Dr. Byron tied the femoral artery in the upper third without difficulty, and with the effect of putting an immediate stop to the hæmorrhage. The vis vitæ, however, had been previously too far exhausted to allow of salutary reaction, and the limb passed rapidly into gangrene, which quickly extended to the groin, and carried him off in a few hours.

The examination discovered a longitudinal slit, nearly a quarter of an inch long, in the front of the popliteal artery, close to which lay a jagged portion of sequestrum; this was thin and sharp, and formed a part of half the circumference of the cylinder of the old bone, the greater portion of which was firmly incased in the new one.

¹ 'Med.-Chir. Rev.,' vol. xxiv, p. 259.

CASE 26.—*Æt. 19. Similar to Cases 24 and 25.*¹

Similarity in situation of wound in artery; recurrence of bleeding at frequent long intervals; infiltration of limb; exhaustion of patient; amputation and recovery. —Dr. JACOBS. Wound transverse, vessel being nearly cut across; sequestrum, although moveable, unable to be extricated.—Quoted by TUFFNELL.

CASE 27.—*Supposed ulceration of ruptured artery; slow extravasation; sudden rapid increase; exploratory incision; amputation; recovery.*²

H. Richard D—, æt. 45, admitted into St. Thomas's, under Mr. Travers; of sallow, exsanguineous appearance, and out of health. Admitted with very extensive swelling on the inner side of the thigh and ham of right side. There was no proper history to be obtained. He stated that about ten weeks since he had been engaged mowing grass with unsound shoes, which had caused his foot and leg to inflame and swell; that shortly after a number of red spots appeared on his legs; a few days after this, when the inflammation had reached the thigh, while sitting in his chair before the fire, he felt something give way, and that he had a sensation of trickling down the thigh; suddenly turned pale and fainted, and should have fallen to the ground but for immediate support. He is certain the swelling began from below and extended upwards. The thigh became enormously swollen, and beat very quickly; but after three or four days the pulsation ceased, whereas the swelling increased from day to day. The leg had been fomented and leeches.

On admission, there was a large swelling occupying the lower three fifths of the thigh, extending into the popliteal space; although not circumscribed, it was most considerable on the inner side. It was elastic on pressure, but no fluctuation could be detected; no pulsation could be felt. The integuments were very much discoloured, of a livid colour; and at the upper and inner part of the swelling were two small openings discharging a sanious fluid. The foot and leg were much swollen and œdematous, with desquamation of the cuticle. The femoral artery below Poupart's ligament pulsated more freely than on the opposite side.

A probe introduced at one of the openings passed freely in all directions, and when withdrawn was followed by a sanious discharge.

On the second day after his admission a considerable quantity, about a pint, of dark-coloured fluid escaped from one of the openings. The patient did not complain of much pain, but was much debilitated. An incision was made into the tumour, and a large quantity of grumous blood escaped; the finger introduced passed readily in every direction.

Amputation was immediately performed; recovery.

Examination of limb.—Tumour was found to consist of coagulated blood diffused among the muscles beneath the fascia, in large masses, and from the pressure on the tissues causing their undergoing a change; in the centre of the popliteal space, the artery presented an opening in front; this was of an oval shape, half an inch in length, its edges rounded off by ulceration.

¹ Jacob, 'Diss. Med.-Chir. de Aneurism.,' Edinburgh, 1814.

² Crisp, 'On Aneurism,' p. 227. 'Lancet,' Sept., 1825.

Summary of Cases of Incomplete

No.	Name.	Age.	Occupation and habits.	Cause.	Primary operation.
10	George C—	49	—	From exertion of walking, &c.	Ligature of femoral on fifth week
11	William D—	53	Habitually intemperate	Spontaneous	Ligature of femoral
12	Thomas C—	56	Tailor; unhealthy, pale	Severe fall while drunk	Ligature of femoral on sixth week
13	William W—	36	Carman	Unknown; flying pains in joint	Ligature of femoral, three weeks
14	Man	30	—	Blow on ham, from jumping an iron gate	Compression for two weeks, ligature of femoral
15	John W—	30	Agricultural labourer; healthy	Foot slipped off spade whilst digging	Ligature of femoral three weeks after
16	Male	30	Well developed	Knee forcibly knocked against door	Incision into ham on eighth day, and ligature placed above and below rupture
17	John S—	32	Soldier; robust	Forcible extension of limb	Incision into ham six weeks after injury, and ligature above and below rupture
18	M. L—	Young man	Active, vigorous	Jumping up ascent with knee tense	Ditto, several days after injury
19	Man	30	—	Hurt upon knee	—
20	Male	—	—	—	Attempts at ligature of vessel; amputation
21a	George L—	33	Sallow, emaciated, dissipated, good health	Not assignable.	—
21b	John Staples	33	Lamplighter	Slipped, and ham caught between two boards	—
22	Richard W—	41	Stout; healthy	Fractured femur	Ligature of femoral on fifth day
23	William B—	60	Robust; intemperate	Fractured head of tibia	Ligature of femoral thirty hours after
24	John J—	29	Delicate; drinker	Necrosis of femur; sequestrum of bone	Amputation refused
25	Young man	25	—	Sequestrum of bone	Ligature of femoral
26	Male	19	—	Sequestrum of bone	Amputation
27	H. Richard D—	45	Sallow; out of health	Supposed ulceration of artery	—

Rupture of the Popliteal Artery.

Effects of operation, injury, &c.	Secondary operation.	Result.	Surgeon.	Hospital.
Gangrene; attempts at separation	—	Death	Key	Guy's.
Gangrene	Incision into ham	Death, forty- three days af- ter ligature	B. Phillips	Marylebone In- firmery
Gangrene	Incision into ham	Death, thirty- nine days af- ter ligature	Stubbs	Liverpool.
Fever, diarrhoea, pneumonia	—	Recovery	Scott	London.
Gangrene	—	Recovery	—	King's College.
—	—	Recovery	Pollock	St. George's.
Gangrenethirty-five hours after	—	Death on sixth day	Pelletan	Hospital of Col- lege of Surgeons, Paris.
—	—	Recovery	Pelletan	Ditto.
—	—	Recovery	Pelletan	—
Slow and gradual extravasation	Nine months after, attempts at liga- ture in ham; am- putation	Recovery	Warner	Guy's.
—	—	Death	Pelletan	—
—	Eight months after incision; second- ary hæmorrhage	Death	Green	St. Thomas's.
—	Amputation three months after	Not stated	J. Hunter	St. George's.
—	—	Recovery	B. B. Cooper	Guy's.
Gangrene	—	Death, eighth day	Key	Guy's.
Gangrene	—	Death	Porter	Meath.
Gangrene	—	Death	Byron	Meath.
—	—	Recovery	Jacob	—
Slow extravasation, sudden increase	Exploratory inci- sion; amputation	Recovery	Travers	St. Thomas's.

B. INDIRECT.

SERIES III. *Rupture of a popliteal aneurismal sac, &c.*

This series comprises cases of bursting of an aneurismal sac, either from external violence or otherwise, as well as cases of ruptured artery close to the aneurismal sac. In these instances, we shall find that the symptoms, progress, and treatment very much resemble those of the foregoing series; but they possess this additional advantage, viz., the existence of a previous diseased condition of vessel, as indicated by the presence of a pulsating tumour. However, in some of the instances, the rupture occurred previous to medical observation, and then only a confused history, given by the patient, of the previous antecedents; so that, in more than one case, the diagnosis was rendered anything but satisfactory. We shall pursue the same line of investigation in these cases as adopted in the other series, but shall, in addition, first premise a few remarks on the antecedents of each case, previous to the occurrence of the rupture. The number of cases collected in this series amount to 42 in number.

Of the antecedents previous to the rupture.—In all of the present series there has been, for a longer or shorter period, an aneurism of the artery, and we shall cursorily review the length of time or duration of the existence of the disease previous to the rupture or perforation of its sac.

In Case 28 we have an accurate description of the formation of a popliteal aneurism, as being apparently of spontaneous origin; this continued steadily increasing for four or five months, attaining the size of a man's head, causing excruciating agony and limited movement of the knee. It is very questionable whether the sac had not given way for some time; and it is also a matter of probability as to the real nature of the disease being a ruptured artery, with direct extravasation of blood, as in Case 21B.

In Case 29 there was an aneurism of five months' standing, attended with intense pain and cedema of leg, foot, ankle, and knee.

Case 30. Observed a tumour for four months, and attributed it to a hurt received from a door, as she was in the act of running out of a room, when the thigh was forcibly caught between the door and the frame. Gradual and steady increase to size of walnut, and pulsations so strong as to lift the thigh and leg off, when placed across the opposite one. It is questionable whether this was not a ruptured artery without aneurismal sac.

Case 31. The aneurism came on after a march of twenty-three miles over a mountain-road; he was admitted into the military hospital on the seventh day; was treated by compression for ten days, applied three inches below Poupart's ligament; a slough was produced, which cicatrized (an inch and a half long by one inch wide). Compression again used, an inch lower down, with similar results. After nine months in hospital, returned to England, and no effects found to have been produced on the aneurism; he again underwent compression for thirteen days over the middle of the thigh, which caused a deep slough, and over the inguinal region, where there became a superficial one; when these ulcers were healed he was discharged, the tumour having rather increased in size, having been in the last hospital five months. About five months after this, rupture of sac took place.

Case 32. Aneurism of six months. No detail.

Case 33. Had undergone much hardship in the Crimea; eight weeks before admission, an aneurism formed in the left popliteal space, which rapidly increased in size, and ultimately became as large as a cricket-ball; the foot and leg were oedematous. Compression was employed, and the aneurism was undergoing a process of cure, becoming hard and of original magnitude, and impulse scarcely perceptible.

Case 34. A soldier had been troubled with pain in the ham for twelve months, and it was only after a field-day, two days before admission, that he discovered any tumour, which was small, well-defined, and pulsating, but this on the third day became diffused.

Case 35. Aneurism of six weeks' standing.

Case 36. Aneurism noticed six weeks, but he had numbness in leg for two years.

Case 37. Fifteen years ago felt a pain in both hams, and soon after perceived a tumour in each. These became somewhat larger when exposed to fatigue or cold. From the commencement a throbbing was felt in them, but the patient was never prevented from attending to the duties of his occupation as infantry soldier. These symptoms continued stationary until the present accident.

Case 38. Aneurism of two months' duration.

Case 39. Noticed five weeks a swelling towards the inner and back part of the thigh, about the junction of the middle with the lower third of limb; at the commencement of popliteal artery it was circumscribed, throbbing, and tender. He kept on working for three weeks, when it continued to increase, attended with pain in the knee, and extending down the back of the leg to the ankle and foot, and with numbness and inability to move the leg.

Case 40. Popliteal aneurism of only three weeks' notice.

Case 41. Popliteal aneurism of eleven weeks' duration; ineffectual attempts at compression; ruptured.

Case 42. Discovered three months ago a pulsating tumour in ham, with pain shooting down the leg. He continued his work for a month, when he sought advice. He was directed to apply a poultice to the part; and as this gave no relief, a puncture was made into it with a lancet; nothing, however, escaped; but severe hæmorrhage came on on the following day, when tourniquet was applied, and he was sent to the hospital.

Case 43. Not stated. No accurate history.

Case 44. Aneurism of eight weeks' duration.

- Case 45. Aneurism of three months, size of walnut, and attended with pain and pulsation ; leg began to swell ; pulsation ceased.
- Case 46. Disease existed five years without suspicion, the patient considering the lameness to arise from gouty rheumatic affection of the knee, and continued to follow his trade of organ-builder up to the present period.
- Case 47. Aneurism, one year.
- Case 48. Aneurism appeared four months ago, and became painful and large within last two weeks, and during his last voyage as sailor was unable to get out of his berth.
- Case 49. Eleven months ago, after carrying a heavy sack of wheat up some steps, experiencing at times a tingling sensation in front of right knee, he noticed a small swelling ; this disappeared in a few days ; in nine months after this he again noticed the swelling, and that it throbbed, accompanied with pricking sensation up the thigh. It gradually increased to size of pigeon's egg.
- Case 50. Aneurism of size of orange, noticed two weeks and cured in forty hours by compression, and in twenty days was reduced to size of pigeon's egg and perfectly solid, without pulsation. On 21st day, sudden bursting of artery above tumour.
- Case 51. Two years previously received a hurt in the knee, and six weeks before admission got a blow in the ham from a stick ; no attention paid to this, and continued working in digging coals out of a ship ; led a reckless life, and when first seen it was at his lodging, in intoxicated state.
- Case 52. Eleven months' duration, and attained size of goose's egg. Compression attempted, and could not be borne ; operation refused ; after several days, rupture.
- Case 53. Three months before admission, whilst going down stairs, his foot slipped, and he felt something give way in back of leg. Recovered from the effects, and continued to work up to three weeks back, when tumour in ham enlarged in bulk and became painful ; it filled up the lower half of the popliteal space. Compression of femoral for a week, and with apparent good effect, when rupture took place.
- Case 54. For six weeks felt swelling in left ham, but continued to work for a month, when limb swelled and became painful. An aneurism occupied right ham, size of an egg ; indolent ; leg sound. Underwent ordinary compression for seventeen days, then digital compression for ninety-four hours, and apparent cure, when, on ninth day, after leaving off compression, rupture took place.
- Case 55. Fifteen months ago he wore, for two months together, a pair of tight, leathern breeches, which made his legs swell and become so painful that he was obliged to leave them off. About a month after this, after walking ten miles on a very hot day, he felt uneasiness in hams of both legs, and in the course of the night observed a swelling in each, and that of the left was pulsating. The left gradually increased and diffused itself. The right was of the size of a nutmeg.
- Case 56. Tumour existed for five months, and remained of moderate size until five weeks previous to admission, when it suddenly enlarged and increased considerably from that time. Had never noticed any pulsation in it.
- Case 57. An insane Portuguese. No history, except that the swelling first commenced about two months back.
- Case 58. Pulsating tumour of size of walnut, following a pain in ham, and only noticed some days, when it suddenly burst.

Case 59. Had been for many years in the habit of walking great distances, and had travelled upwards of 100 miles in two days very shortly before he was taken ill. Disease commenced two months before admission, with considerable pain in calf of leg, which shortly confined him to his bed, followed by œdematous swelling of left ankle. The pain and swelling increased, and health affected. He was not at any time conscious of the existence of a distinct tumour or pulsation.

Case 60. The patient denied that any tumour or uneasiness had existed previous to seven weeks before admission, when, without any assignable cause, the whole leg and foot became swollen and tense, and ultimately settled into the present tumour.

Case 61. Popliteal aneurism and symptoms of organic disease of heart and whole arterial system.

Case 62. About twelve months ago he received a blow on the fore part of the knee, causing pain, but this gradually subsided; and on another occasion, whilst walking, he suddenly felt something give way in the ham, and his knee became at once stiff and painful. Eight months after this he observed a swelling about the size of an orange in the ham; no pulsation at first, but afterwards it was very evident.

Case 63. Aneurism of six months' duration, of size of goose's egg, entirely filling up ham, and was more prominent on its upper and outer side, where an opening had been made with a lancet, three days before admission, by a country practitioner, which operation was followed by slight bleeding; a bandage was applied.

Case 64. Aneurism of three weeks' observation, of size of orange. Compression employed, and successful at end of twenty-seven days. Left hospital quite well twenty-five days after this sudden rupture.

Case 65. Suffered from aneurism eight months. Tumour of considerable size, but did not quite fill the whole space; it extended upwards and outwards. Compression of femoral employed, and continued for a week, when all pulsation had ceased. At this juncture rupture took place.

Case 66. Eleven years previously received punctured wound of popliteal artery, requiring ligature of femoral, and recovery. Subsequently had never the slightest inconvenience, nor even aware of existence of any tumour or swelling till, five weeks before admission, after recovering from fever, he found the leg stiff, painful, and swollen, which increased.

Case 67. Stated that twenty years ago he experienced an injury to the knee, and that ever since it had been weaker than the other, and he thought that a swelling had remained behind the knee up to the present time, but had not grown larger, nor caused him much annoyance.

Case 68. Double aneurism.

Left, of two months' duration, large, soft, and fluid. Compression unsuccessful; ligature of femoral; secondary hæmorrhage; reapplication of ligature, and progress favorable.

Right, observed only on admission. Ligature of femoral, followed on second week by rupture of sac.

Case 69. Aneurism size of orange, stated to be of only three days' standing.

The causes of ruptured sac was made mention of in 15 cases.

It is presumed to be spontaneous and unknown in 14 cases, viz., Cases 30, 31, 36, 39, 40, 46, 48, 50, 56, 57, 59, 60, 65, and 66; in Cases 40 and 50 it was sudden, and in Cases 39, 46, 59, and 66, it was gradual and successive. In 13 cases no record was made.

The causes were—In Case 28, while walking on crutches, one of them slipped, and he fell to the ground, bruising the swollen limb; but it appears probable that the rupture had existed previously. In Case 29, as the woman was trying to hobble through the room, she fell forwards on the floor, and is said to have strained the veins, particularly one running up the thigh, which became hard and black. Case 37, whilst labouring under popliteal aneurisms on both sides, which had existed fifteen years, the right leg was much and severely bruised between two cows, in his employment as cattle-drover. In Case 67, whilst carrying a sack of coals up the ladder of a waggon, his foot slipped, and he fell, twisting his knee upon the lower rail. In Case 51 there was blow on the sac. In Cases 42, 43, and 63, the aneurism had been punctured with a lancet, which caused the extravasation and in Case 62, although a rupture had probably taken place, yet the swelling increased after the introduction of a lancet. In Case 58 it occurred during a fit of sneezing. In Case 34, from over-exertion after a field-day as infantry soldier. In Case 49, while engaged in hoeing turnips, he felt something give way in the ham, and experienced rushing sensations down the leg and up the thigh in the course of the femoral artery. In Case 35 there was no particular cause for the aneurism, but it was very large, and was treated by forcible flexure and compression, and burst into the knee-joint. In Case 47 it occurred suddenly four days after leaving off compression on the femoral artery; and in Case 69 it took place suddenly on the eighth day of using compression.

1. *The sensation of something having suddenly burst or given way* is not frequently observed; thus it was only noticed in 3 cases.

In Case 29 she felt one night rather suddenly a remarkable sensation in the limb, as if the whole swelling was being drawn up from the ankle into the knee; in Case 58, after a fit of sneezing, he felt something burst in the tumour; and in Case 61, about eleven days after admission, he noticed that something gave way in his ham, after which he experienced great suffering. In Case 59 it is mentioned that there was no sensation of sudden bursting.

2. *Increase in the swelling or tumour, and in the size of the limb*, may be sudden and rapid, or slow and gradual, depending on the size of the rent and the situation thereof, &c.

In 31 cases this symptom has been recorded: in 21 it was rapid and sudden: thus, in Cases 29, 34, 36, 41, 48, 49, 54, 56, and 62 there was rapid increase; it was sudden in Case 31, preventing his walking; in Cases 39 and 61 it became diffused; in Case 50, attended with immediate vast effusion, so also in Cases 40 and 52; in Cases 42, 58, 64, 65, 68, and 69 it was sudden and rapid.

In 10 cases it was gradual and slow—in Cases 30, 35, 37, 45, 46, 55, and 59; in

Case 28 there was steady increase, reaching the size of a man's head, and still continuing to enlarge; in Case 66 it was at first slow and gradual, but afterwards became sudden and rapid; and in Case 33 nothing further was noticed than the aneurism, which was in process of cure, and the gradual œdema of the leg and foot.

In 11 cases no mention is made—Cases 32, 38, 43, 44, 47, 51, 53, 57, 60, 63, 67.

Condition and character of the tumour after bursting of the sac, appearance of the skin, &c.—This will in some measure depend upon the foregoing symptom, viz., the slowness or rapidity with which the blood is extravasated, for in the one instance the tumour will attain a degree of firmness and solidity, whereas in the other it presents a fluctuating, elastic, tense feeling; but it will also vary according to the situation of the aneurism, whether it be above, opposite to, or below the bend of the knee; thus, when aneurism is seated at and above the knee, the tumour arising from the bursting of its sac in general will become large, superficial, and very evident; whereas, when it is seated below the bend of the knee, under the gastrocnemius, there will be an indistinct and diffused swelling of the calf; even the aneurism itself, in this situation, is often unrecognised. This fact did not escape John Bell when he wrote the following words:

“It is in aneurisms of the popliteal artery, often confined under the bellies of the gastrocnemii muscles, and betwixt the tendons of the hamstrings, that the resistance to its extension is very great; the destruction within is proportionally rapid, and the disease is always attended with severe pain. The tumour is not always clearly circumscribed, nor to be fairly traced to any connexion with the artery; and being covered and its pulse suppressed by the great thickness of the muscles and skin, the nature of the disease remains unknown. From the same pressure the leg becomes very early cold and œdematous; for the veins, lymphatics, and artery all pass in this straitened cavity of the ham, the pressure upon these produces a general swelling of the limb, and the general swelling conceals the particular tumour. From the elevation of the bellies of the gastrocnemius muscle over the tumour, and from the distension of the hamstring-muscles, the limb is thrown into severe and painful cramps; and from the nerve passing over the tumour (pressed sometimes

quite flat) a very distressing numbness is always felt, and the lameness and pain are such as the external swelling cannot account for.”

We shall make no general summary of this set of symptoms, but will give the actual condition of the tumour, and its characters, as reported in each separate case. There are only 4 cases in which this was not stated, viz., 40, 49, 52, and 58.

Case 28. Skin over whole extent of tumour greatly inflamed and very tense; an oozing of bloody serum had taken place from the most depending part of the tumour, where the cuticle had burst.

Case 29. Tumour principally seated above knee; a process seemed to extend deep into the upper part of the calf of the leg, and another upwards along the course of the biceps. The mass well defined, round, and prominent below, not so well marked above, and laterally embracing the entire circumference of limb; surface smooth and slightly polished from the tension; circumference in measurement is $16\frac{1}{2}$ inches. On touching it lightly there is no sense of fluctuation, but on pressing heavily with the thumbs a sensation of deep-seated fluid communicated.

Case 30. Large, pulsating tumour occupying lower part of thigh, for 6 inches above the patella, and extending spirally backwards and downwards as far as head of tibia; shape appeared to be irregularly quadrilateral; no discoloration of the integument over it; outline of patella lost, and natural shape of joint destroyed. Three inches above the patella the circumference of limb was $17\frac{1}{2}$ inches, and the patella $16\frac{1}{2}$ inches; on corresponding limb it measured respectively $16\frac{1}{2}$ and $14\frac{1}{2}$ inches. Indistinct fluctuation could be felt.

Case 31. The tumour extends from about 3 or 4 inches above the ham to the upper part of middle third of leg; it measures round the upper part 19 inches, lower part $17\frac{1}{2}$ inches; length of tumour, 6 inches. It extends on each side above and around the condyles of the femur.

Case 32. Limb around tumour measures $20\frac{1}{2}$ inches; the opposite limb at same part, $12\frac{1}{2}$ inches.

Case 33. On twenty-first day of aneurism undergoing compression, several bullæ, which had formed on instep, on different parts of the leg, and popliteal region, burst, and a large quantity of serum, tinged with blood, passed from the limb, and more or less continued to ooze from various points for the next six days.

Case 34. Large, diffused, hard swelling on inner side of ham, extending half-way up the thigh, and round to the inner and fore part, but not ascending so high in this direction, and continued to increase.

Case 35. A very large aneurism, $5\frac{1}{2}$ inches long, burst into knee-joint; knee altered in shape, and patella raised.

Case 36. Alarming swelling, limb twice the size of the other, and swelling reaching to groin; integuments tense and discoloured, and of yellowish colour; parts below the knee natural; limb heavy.

Case 37. Tumour increased shortly after accident, and remained thus for six weeks, the man resuming his labours and exercising limb; but it soon increased and

became more diffused; veins upon surface of limb very distinct; a slight erysipelatous blush over the inside. Tumour became daily more tense and extended.

Case 38. Tumour occupied a large extent of surface, and was rapidly increasing; was hot and painful; became red and much more tender, and skin exceedingly thin, when it suddenly burst.

Case 39. In the popliteal space, or rather just above this, and over the course of the femoral artery, was a hard, firm, moveable mass, discoloured over a portion of its surface, and marked by enlarged, superficial veins; was tender and painful on pressure.

Case 41. Sudden increase; tumour extending 2 inches up inner aspect of thigh.

Case 42. Enormous, diffused extravasation about ham, leg, and thigh.

Case 43. Similar to Case 36; of considerable size.

Case 44. Elastic, circumscribed tumour, which was so large as not only to fill up ham, but to project beyond the space defined by the hamstrings. After ligature, tumour reduced in size; but thirty-three days after operation, distinct sense of fluctuation around joint.

Case 45. Ham and leg twice the natural size; integuments of calf exceedingly tense, of a dark-brown colour, with sense of fluctuation; the tenseness increased, and the limb measured half an inch more round the calf than before, and became more discoloured.

Case 46. Extensive tumour, occupying ham and extending over the sides of the condyles of the femur towards the patella, and reaching some way under the gastrocnemius. Integuments at the back part of it were at one point somewhat red and inflamed. Had an attack of gout, lasting two weeks, when, on subsidence, not any alteration in the appearance of the swelling and limb, except a slight discoloration above the inner malleolus resembling an ecchymosis; it remained as tense and as large as ever.

Case 47. Tumour occupied whole of ham; compression for four days; dark spot appeared on tumour, which burst five days after leaving off pressure.

Case 48. Tumour remarkably tense and hard to the touch, and shining; knee-joint greatly enlarged; aneurism found afterwards to have burst into joint. Tumour became more tense and hot, and two ecchymosed patches appeared on the inner aspect of the tumour.

Case 50. Vast effusion; acute inflammation of knee ensued; whole ham distended; measurement of knee, 15½ inches, and reached to 18 inches, the healthy one being 13 inches; a crimson blush appeared on surface.

Case 51. Ham swollen to great size, and entirely filled up; limb livid and veins turgid; compression of femoral for three days, with diminution in size of swelling; on seventeenth day tumour suddenly became more diffused, and limb swollen and congested; on twentieth day vesication on ankle and leg, and gangrene feared. Left hospital suddenly on fifth week, and returned in two days in state of intoxication; limb found not in a worse condition. Tumour went on increasing, and blood came quite near the skin, which was discoloured, corrugated, and tightly stretched over the blood, threatening to break, and veins distended and red; gangrene momentarily expected; effusion into knee-joint (not blood).

Case 53. Tumour filled up lower half of popliteal space; after a week's compression of femoral it became firm and solid, but attended with engorgement of limb, and

soon followed by mottled appearance of skin and distension amounting almost to bursting.

Case 54. Soft, fluctuating, of size of fist; large effusion into knee-joint, fluctuating, but no pulsation; it underwent change during compression, becoming firm, then solid, lumpy, less projecting behind, but much larger at its upper part. The tumour did not lessen.

Case 55. Firm, inelastic swelling, extending from middle of left thigh down to the toes.

Case 56. Large tumour, filling up whole ham, and extending on both sides of the femur towards the front of the limb; it had a firm, fleshy feel, being a little softer at one of its anterior protuberances than in other parts.

Case 57. Large tumour, circumscribed at its upper part, extending from the middle of the inside of the right thigh to the inner part of the knee-joint; the skin covering it was discoloured; there was a deceptive feeling of fluctuation.

Case 59. No distinct tumour, but general swelling of limb, reaching as high as lower third of thigh; it was twice the size of the other, and had a distinct feeling of fluctuation, as of matter underneath.

Case 60. Tumour about 14 inches in circumference, occupying the lower third and inner side of thigh, presenting its greatest bulk in that situation, and gradually decreasing forwards to the ham and the outer side of the thigh. Its circumference had a defined margin; the summit was tense and elastic, and gave to the touch an evident sense of fluctuation; the integuments retained their natural colour.

Case 61. Aneurism became diffused after bursting of sac; ham continued swollen for seven days, when fresh rush of blood, and the calf and entire back of leg enlarged, tense, and swollen almost to bursting; it was hard and shining, presenting in many parts a dark, mottled appearance.

Case 62. Enormous swelling of ham and inner part of knee; slightly elastic; integuments a little discoloured; surface smooth on exploration; on following day sudden increase of swelling; integuments of a blackish appearance, very thin, tense, and hot; oozing from puncture; circumference of limb, above knee, about 2 feet.

Case 63. Three days after puncture of aneurism by lancet, surface of tumour of a purplish-reddish colour, and tumour filling up ham, when sudden bursting through external wound.

Case 64. Much enlargement of knee; integuments firm, stretched and livid; these gave way, and allowed hæmorrhage.

Case 65. Tumour of considerable size, but did not quite fill the ham, and extended upwards and outwards; under pressure of femoral, pulsation ceased, when on seventh day sudden increase, &c.

Case 66. General enlargement and œdema from knee down to toes, but chiefly at the back of the leg, where the calf bulged out into a prominence, extending from the knee to rather more than half-way down; was tense and tender. Deep-seated fluctuation was very distinct, and there was evidently a large collection of fluid under the gastrocnemius. Opened by lancet; gradual subsidence of swelling and limb to natural size; on fifteenth day sudden arterial hæmorrhage and diffusion of blood into tissues; the entire leg became swollen, shining, and livid; integuments tense, and greatly distended.

Case 67. Eight hours after accident knee and ham very tensely swollen and discoloured by ecchymosis, and very painful to the touch.

Case 68. Enlargement and tenderness of ham; an intensely painful swelling appeared towards lower end of tibia; superficial veins over calf purplish and very distinct; integuments soon became dusky.

Case 69. Sudden tumefaction of parts and limb; the popliteal tumour appeared unchanged, but an additional swelling was found on inner side of joint, circumscribed and flattened; about twice the size of palm of hand, with considerable prominence and but slight pulsation.

4. *The presence or absence of pulsation in the popliteal swelling.*

In 6 instances these circumstances are not mentioned, and in all probability, if pulsation had existed, it would perhaps have been noticed; but we will not include them in the general summary. These cases are 47, 49, 52, 58, 64, and 68, thus leaving us 36 cases to draw conclusions therefrom.

In the following 14 cases there was no pulsation. Case 29, no pulsation, and on applying the stethoscope no sound could be heard; in Cases 36, 42, 43, 45, 55, 56, 59, 61, and 65, there was no pulsation; in Case 57 there was no pulsation, either by touch or by the stethoscope; compression with the hand did not in the least reduce the volume of the swelling; in Case 62 pulsation ceased, and no bruit heard; in Case 63 the tumour was without pulsation, and on examination with the stethoscope one could not detect any *soufflet*; under moderate pressure it was quite compressible, but on its removal the tumour rapidly resumed its original form and bulk; the femoral artery acted most violently. In Case 66 not the slightest sense of pulsation in the tumour, nor the faintest sound or murmur could be detected in the tumour of the calf, and it was totally uninfluenced by pressure on the femoral.

In 9 cases there was at first some pulsation, but which became weaker and in some entirely ceased; thus, in Case 28, at first it could only be discovered by pressing firmly with the fingers on the upper part of the tumour; however, soon afterwards all pulsation ceased entirely. In Case 33 the pulsation in the aneurismal tumour, while undergoing compression of the femoral, became imperceptible on the seventeenth day, and could no longer be detected. In Case 39 there was a weak pulsation to be felt with the hand, and arrested the moment pressure was made on the artery in the groin; and when the pressure was taken off, a fresh and sudden rush of blood into the tumour could be distinctly felt. In Case 42 there was at first distinct pulsation, but gradually became weaker. In Case 44 it afforded to the touch a distinct thrilling sensation, and pulsation of the femoral was strong. In Case 48, upon superficial examination, no pulsation could be felt in the tumour; but when firm pressure was made for some moments by the finger, these last had a movement and impulse communicated to them corresponding to the patient's pulse; when the stethoscope was applied with some pressure on the swelling, a distinct but rather muffled *bruit de soufflet* was audible. When the femoral artery was compressed, all pulsation and *soufflet* ceased, the shining tension of the skin lost, and the popliteal swelling flaccid and soft. In Case 60 no pulsation could be detected in the enlarged

surface, except to a slight degree at that part which lay immediately over the popliteal artery; pressure on the femoral produced no diminution in the bulk of the tumour, nor could any sound be detected on the application of the stethoscope. In Case 53, after undergoing compression of the femoral, the pulsation in the sac became evidently less distinct; and on its outer side a distinct, pulsating vessel was discovered, indicating a collateral circulation; this pulsation gradually lessened, as extravasation went on. In Case 54 there was pulsation, and a *bruit de soufflet* heard only at the upper and inner part; and after compression of the femoral, the pulsation in the tumour entirely ceased, but at the sides of the knee pulsation was very manifest; there was no *bruit de soufflet* afterwards, and the pulsation diminished daily.

In the remaining 13 cases there was distinct and evident pulsation in the tumour. In Case 30 there was a distinct, pulsating tumour; and a distinct *bruit*, best marked at the upper part, was audible all over the tumour synchronous with the systole of the heart; the tumour could be diminished by making firm pressure on the femoral above, but this diminution was very slight. In Case 31, by auscultation, a *bruit de soufflet* is audible, principally on the outer side over the head of the fibula, and on the inner side behind the head of the tibia; by pressure on the artery in the thigh, the size could be slightly diminished, but returned to its original bulk on removal of the pressure. In Case 32 there was pulsation. In Case 34 the swelling in every part had a pulsatory movement synchronous with the pulse, and arrested by compression of the femoral, when a slight subsidence of the swelling was observed; there was a whizzing sound heard by the stethoscope. In Case 35 a pulsation existed in the enlarged knee, which filled and emptied as pressure was made on the femoral and taken off. In Case 37 the pulsation augmented, and in six weeks was much diffused over the tumour. In Case 38 the tumour beat strongly. In Case 41 there was general pulsation. In Case 46 the pulsation was remarkably strong, and equally manifest both to sight and touch; he had an attack of gout for two weeks, and the throbbing of the tumour diminished considerably, so that in a few days there was no pulsation whatever; by direct auscultation a bellows-murmur was heard, hence still a current of blood into the aneurismal sac. In Case 50 there was forcible pulsation. In Case 51 an impulse in the swelling. In Case 67 the pulsation was not very apparent at first in the swelling, but afterwards it became more decided, especially towards the inner side; and in Case 69 there was pulsation.

The pulsation in the tibial arteries was only recorded in 7 cases. In Case 34 there was weak pulsation in the tibials. In Case 44 indistinct pulsation. In Case 66 the tibials could be felt pulsating after displacing the subjacent œdema by pressure. In Cases 48, 57, 61, and 67, no pulsation could be felt.

The above analysis disproves in a measure the opinions advanced by Porter, in his work on Aneurism, respecting pulsation in the tumour, formed by the bursting of the vessel or sac. He says, "Pulsation is either absent or scarcely appreciable, and when any approach is made to it, it is little more than a weak, indistinct thrill; the reason of this is easily

understood. When the blood is thrown out of the vessel, it lies in the cellular tissue as an inert coagulated mass; there is no reacting force to recoil upon the fluid blood, and return a portion of it back into the circulation; *bruit de soufflet* is seldom observable."

5. *The presence or absence of pain in the tumour and limb*, noticed in 28 cases.

There was not much pain in Case 45. In Case 39 there was pain in the knee, extending down the back of the leg to the ankle and foot, and also up to the hip; a throbbing pain in the tumour, and a pricking sensation in the knee. In Cases 38, 63, and 64 some pain was complained of. In Case 30 the whole leg was affected with painful twitchings. In 11 cases there was severe and considerable pain, viz., in Cases 31, 34, 44, 48, 50, 53, 58, and 67. In Case 56, although great pain in the leg, yet the tumour was not tender on being handled. In Case 59, although considerable pain in the tumour, yet not much tenderness in different parts of the leg. In the remaining 12 cases the pain was acute and most intense: in Case 28, described as excruciating and almost intolerable. In Case 29 intense pain about the knee, which became desperate. In Case 37, the tumour became so painful, and attended with such a sensation of constriction in the limb, as to deprive him totally of rest. In Case 41 writhing pain all over the knee. In Case 51, the pain became very intense. In Case 52 it was most agonizing about the knee and leg. In Case 54 there was intense agony and pain down the leg, lasting for three hours at a time, while undergoing digital compression; and on the ninth day after leaving off compression there was very violent pain in the calf, which became most acute. In Cases 55, 61, 68, and 69 it was most acute. In Case 62 it was so acute that the man urged to have his leg off.

6. *Condition of the sensation in the limb*, observed in 10 cases.

The leg and foot were benumbed in Cases 28, 30, 37, 49, and 52. In Case 36 there was very little feeling in the parts below the knee. In Case 39 the numbness of the leg became so great, that when touched or pinched the patient was scarcely conscious of the fact. In Case 44 there was a tingling sensation in the foot. In Case 46 the foot was torpid, and in two weeks there was increased numbness; and five days after this there was loss of sensation in the toes, which soon extended to the ankle. In Case 67 there was a feeling of numbness extending down to the toes, which increased, so that on the fourth day sensation became lost up to the middle of the leg.

7. *Temperature of the limb*.—This symptom has unfortunately not been recorded in more than 8 cases:

In all of which the heat of the limb was diminished and reduced, rendering the foot cold and benumbed, as was observed in Cases 30, 32, 37, 41, 52, 61, and 64. In Case 46, in the course of two weeks the foot became all of a sudden extremely cold, but afterwards became warm, owing, probably, to artificial means. Mr. S. Cooper, in his remarks on the latter case, and on cases of ruptured aneurism, observes, "There is a sudden fall in the temperature of the foot after a remarkable decline in the aneurismal pulsation, or after they have become imperceptible; and that we are not to be deceived by the artificial warmth induced by the application of hot fomentations, &c. The circulation in these cases becomes seriously obstructed, the foot soon turns cold, and, if the extravasation attain a certain degree, mortification ensues, whether the femoral artery be tied or not."

8. *Œdematous and swollen condition of the limb*, as indicating an embarrassed circulation and a pressure on the vessels, observed in 31 instances.

In 4 cases it was but slight—Cases 30, 41, 44, and 68; in 15 it was described as swollen and œdematous, as affecting the foot, ankle, and leg—Cases 37, 38, 45, 48, 49, 50, 51, 52, 59, 60, 62, 63, 64, 65, and 66; and in 11 cases the limb was extensively and greatly œdematous, viz., Cases 29, 33, 34, 39, 46, 47, 53, 54, 56, 57, and 67; in Cases 47 and 53 more so than the others, the limb becoming enormous in size.

9. *The position of the limb* is said to be generally flexed, and that any attempt to extend it causes great pain. It has been taken notice of in 9 cases.

In Case 28 the limb did not admit of flexion or extension. In Case 30 it was flexed at an obtuse angle on the thigh. In Case 31 the knee-joint was bent, the leg being nearly at a right angle to the thigh, and could not be made straight. In Case 32 the knee was a good deal bent and fixed. In Case 39 the knee was stiff, and there was an inability to move the leg. In Case 44 the motions of the knee were much impaired, and leg kept continually in a semi-bent position. In Cases 54 and 60 limb was semi-flexed, and could not be extended. In Case 63 the entire limb was flexed on the pelvis.

10. *The supervening of gangrene*, from the effects of the ruptured sac.

A. Where ligature of the femoral was not employed, observed in 7 cases. In Cases 51 and 52 a manifest disposition to gangrene. In Case 54 a slough of the size of a five-franc piece formed over the popliteal tumour. In Case 58, two or three days after bursting, gangrene commenced in the instep and foot, and quickly spread upwards, accompanied with severe constitutional irritation. In Case 64 the lower part of the leg was gangrenous; the gangrene became arrested a few inches below the knee. In Case 65 lividity of foot and rapid gangrene. In Case 67 there was gangrenous discoloration on the third day, and upon the toes

and heel patches of vesication and appearance of gangrene, which gradually extended over the whole foot and up the leg, without any line of demarcation.

B. Gangrene coming on after ligature of the femoral noticed in 8 cases, viz., Cases 36, 38, 41, 42, 46, 47, and 68.

11. *The bursting of the sac, &c., externally, causing hæmorrhage*, primary and secondary ; observed in 14 cases.

In Case 28 there was bursting externally, and four pounds of blood were lost, but recovery without any secondary hæmorrhage. In Case 29, sudden hæmorrhage through punctured wound in the tumour. In Case 31, during the cure by compression, an opening was made into the fluctuating part, and twenty ounces of grumous blood escaped ; as also, some time after, fibrous laminæ. In Case 32, after two months' compression, with partial success, an attack of erysipelas of the leg came on, and soon after this the tumour burst, discharging grumous blood and portions of coagula ; no further hæmorrhage ensued, and was recovering, when another attack of erysipelas and difficulty of breathing followed, with death on the next day. In Case 33, on the twenty-seventh day of the process of curing the aneurism by compression, a sudden external hæmorrhage and immediate death took place. In Case 38 there was a sudden bursting through the skin, and blood was projected to a great distance ; about two pounds were lost. In Cases 42, 43, 60, 63, and 65, hæmorrhage occurred through a lancet wound, and in one to a most alarming extent ; in another, on the third day, a large jet came out *per saltum*, and in a full stream, being restrained temporarily by pressure with the finger and the application of a tourniquet ; and in another hæmorrhage did not cease until the fifteenth day after the puncture. In Case 44 arterial hæmorrhage occurred from the lower part of an exploratory incision in the ham, after ligature of the femoral had been applied, and necessitating the amputation of the limb. In Case 47 there was a large aneurism, and treated by compression on the femoral for four days, when it was left off for the five following days ; then the sac burst externally, and blood escaped to the amount of a pint ; hæmorrhage recurred next day, when the femoral was ligatured. In Case 64, on the sixth day, hæmorrhage to a considerable extent took place from the ham.¹

DIAGNOSIS.—The previous history of the case, the sudden enlargement of the pulsating tumour, and the continuance of this pulsation after the rupture, form such distinctive characters as to render the diagnosis of the lesion easy and unerring ; but although in 13 cases these conditions were more or less present, and in 9 others only partially and imperfectly ascertained, yet in 14 cases there was no pulsation whatever, but merely a large, solid, or elastic swelling, and in many instances accompanied without any definite or distinct history

¹ In Cases 48 and 54 the sac burst into the knee-joint.

- Case 45. Aneurism of three months, size of walnut, and attended with pain and pulsation ; leg began to swell ; pulsation ceased.
- Case 46. Disease existed five years without suspicion, the patient considering the lameness to arise from gouty rheumatic affection of the knee, and continued to follow his trade of organ-builder up to the present period.
- Case 47. Aneurism, one year.
- Case 48. Aneurism appeared four months ago, and became painful and large within last two weeks, and during his last voyage as sailor was unable to get out of his berth.
- Case 49. Eleven months ago, after carrying a heavy sack of wheat up some steps, experiencing at times a tingling sensation in front of right knee, he noticed a small swelling ; this disappeared in a few days ; in nine months after this he again noticed the swelling, and that it throbbed, accompanied with pricking sensation up the thigh. It gradually increased to size of pigeon's egg.
- Case 50. Aneurism of size of orange, noticed two weeks and cured in forty hours by compression, and in twenty days was reduced to size of pigeon's egg and perfectly solid, without pulsation. On 21st day, sudden bursting of artery above tumour.
- Case 51. Two years previously received a hurt in the knee, and six weeks before admission got a blow in the ham from a stick ; no attention paid to this, and continued working in digging coals out of a ship ; led a reckless life, and when first seen it was at his lodging, in intoxicated state.
- Case 52. Eleven months' duration, and attained size of goose's egg. Compression attempted, and could not be borne ; operation refused ; after several days, rupture.
- Case 53. Three months before admission, whilst going down stairs, his foot slipped, and he felt something give way in back of leg. Recovered from the effects, and continued to work up to three weeks back, when tumour in ham enlarged in bulk and became painful ; it filled up the lower half of the popliteal space. Compression of femoral for a week, and with apparent good effect, when rupture took place.
- Case 54. For six weeks felt swelling in left ham, but continued to work for a month, when limb swelled and became painful. An aneurism occupied right ham, size of an egg ; indolent ; leg sound. Underwent ordinary compression for seventeen days, then digital compression for ninety-four hours, and apparent cure, when, on ninth day, after leaving off compression, rupture took place.
- Case 55. Fifteen months ago he wore, for two months together, a pair of tight, leathern breeches, which made his legs swell and become so painful that he was obliged to leave them off. About a month after this, after walking ten miles on a very hot day, he felt uneasiness in hams of both legs, and in the course of the night observed a swelling in each, and that of the left was pulsating. The left gradually increased and diffused itself. The right was of the size of a nutmeg.
- Case 56. Tumour existed for five months, and remained of moderate size until five weeks previous to admission, when it suddenly enlarged and increased considerably from that time. Had never noticed any pulsation in it.
- Case 57. An insane Portuguese. No history, except that the swelling first commenced about two months back.
- Case 58. Pulsating tumour of size of walnut, following a pain in ham, and only noticed some days, when it suddenly burst.

Case 59. Had been for many years in the habit of walking great distances, and had travelled upwards of 100 miles in two days very shortly before he was taken ill. Disease commenced two months before admission, with considerable pain in calf of leg, which shortly confined him to his bed, followed by œdematous swelling of left ankle. The pain and swelling increased, and health affected. He was not at any time conscious of the existence of a distinct tumour or pulsation.

Case 60. The patient denied that any tumour or uneasiness had existed previous to seven weeks before admission, when, without any assignable cause, the whole leg and foot became swollen and tense, and ultimately settled into the present tumour.

Case 61. Popliteal aneurism and symptoms of organic disease of heart and whole arterial system.

Case 62. About twelve months ago he received a blow on the fore part of the knee, causing pain, but this gradually subsided; and on another occasion, whilst walking, he suddenly felt something give way in the ham, and his knee became at once stiff and painful. Eight months after this he observed a swelling about the size of an orange in the ham; no pulsation at first, but afterwards it was very evident.

Case 63. Aneurism of six months' duration, of size of goose's egg, entirely filling up ham, and was more prominent on its upper and outer side, where an opening had been made with a lancet, three days before admission, by a country practitioner, which operation was followed by slight bleeding; a bandage was applied.

Case 64. Aneurism of three weeks' observation, of size of orange. Compression employed, and successful at end of twenty-seven days. Left hospital quite well twenty-five days after this sudden rupture.

Case 65. Suffered from aneurism eight months. Tumour of considerable size, but did not quite fill the whole space; it extended upwards and outwards. Compression of femoral employed, and continued for a week, when all pulsation had ceased. At this juncture rupture took place.

Case 66. Eleven years previously received punctured wound of popliteal artery, requiring ligature of femoral, and recovery. Subsequently had never the slightest inconvenience, nor even aware of existence of any tumour or swelling till, five weeks before admission, after recovering from fever, he found the leg stiff, painful, and swollen, which increased.

Case 67. Stated that twenty years ago he experienced an injury to the knee, and that ever since it had been weaker than the other, and he thought that a swelling had remained behind the knee up to the present time, but had not grown larger, nor caused him much annoyance.

Case 68. Double aneurism.

Left, of two months' duration, large, soft, and fluid. Compression unsuccessful; ligature of femoral; secondary hæmorrhage; reapplication of ligature, and progress favorable.

Right, observed only on admission. Ligature of femoral, followed on second week by rupture of sac.

Case 69. Aneurism size of orange, stated to be of only three days' standing.

The causes of ruptured sac was made mention of in 15 cases.

the evening, and, returning from thence, drank six glasses of brandy; she remembers nothing further. For four or five days she suffered much pain in the calf, the temperature of which was considerably lower than that of the other leg. Under the application of a flannel roller, from the toes to the middle of the thigh, and rest, she gradually recovered, and left in three weeks, at her own request, the limb being in function and appearance as perfect as the other.

Case 31. Left quiet in bed for twenty-two days, when compression was commenced. Limb bandaged, from toes to where compression was made. Notwithstanding the difficulties in its application, the complication of pneumonia, diarrhoea, and phlebitis of opposite limb, compression was persevered in for nineteen days; an eight-ounce weight was used ten or twelve times daily, and gradually decrease to twenty-sixth day. Part of the effused blood decomposed, requiring an opening to be made in the skin; evacuation of twenty ounces of fetid grumous blood; subsequent passage of laminæ of fibrine through wound. Cured at end of five months; the limb nearly straight, and patient able to walk well.

Case 32. Compression with Weiss's tourniquet, substituted afterwards by Bellingham's; continued for two months. On removal, no pulsation in tumour, but no subsidence in size, and had a soft elastic feel. One month after this, erysipelas attacked limb, which became swollen. Soon afterwards, tumour burst externally, and gave exit to twelve ounces of dark matter. No hæmorrhage. In course of two weeks, portions of firm coagula came away. In six weeks he was walking about. At seventh week, another attack of erysipelas and difficult breathing, and death on following day.

Case 33. While undergoing compression for aneurism successfully, rupture of artery above sac; sudden external hæmorrhage and death.

In the remaining cases operative measures were adopted.

Case 34. Compression for six days; but, in consequence of increase of swelling, &c., ligature of femoral. Ligature came away in five months; protracted recovery. Rejoined his regiment with hardly a vestige of the tumour. The limb was rather weak.

Case 35. Forcible flexure and compression for thirteen days used for a very large aneurism, followed by rupture into knee-joint. Ligature of femoral. Ligature came away on twenty-first day. Recovery.

Case 36. Extensive extravasation. Ligature of femoral. Gangrene followed, and death on twelfth day.

Case 37. Ligature of femoral. Recovery. Also ligature of other femoral for circumscribed popliteal aneurism, which had all along remained of same size. Recovery.

Case 38. Compression could not be borne, and arrangement made to tie femoral; it was performed on third day after admission, immediately after bursting of sac externally. Gangrene on fourth, and death on fifth day.

Case 39. Had been salivated, before admission, for supposed rheumatism. Ligature of femoral. Ligature came away on seventeenth day. Recovery.

Case 40. Compression for aneurism with apparent benefit, when sudden bursting of sac; immediate ligature of femoral. Recovery.

- Case 41.** Ineffectual attempts at compression, for five days, for aneurism; badly managed; rupture of sac; ligature of femoral; gangrene; amputation. Recovery.
- Case 42.** Ligature of femoral; gangrene; amputation. Death.
- Case 43.** Ligature of femoral; on following day tumour increased in size, and was as tense as before; secondary hæmorrhage occurred to an alarming extent; sinking; amputation. Recovery.
- Case 44.** Ligature of femoral; erysipelas; inflammation and suppuration about knee and ham; opened on thirty-third day; matter found in joint; amputation. Death in eight days after.
- Case 45.** Exploration by incision of two inches; large quantity of coagulum and arterial blood; ligature of femoral; flow of arterial blood from lower end of wound in ham; amputation. Recovery.
- Case 46.** Operation of femoral urgently advised, but patient desired its postponement for a week or ten days, until he had completed some urgent business; attacked by gout for two weeks; operation again declined and refused for eleven days, when threatening gangrene; ligatures of femoral: gangrene supervened on fifth day; amputation below ligatured vessel. Recovery.
- Case 47.** Large aneurism; compression of femoral for four days; left off for five days, when aneurism burst externally; repeated hæmorrhage; amputation refused; ligature of femoral four days after first hæmorrhage; followed, six days after, by gangrene, and amputation on following day. Recovery.
- Case 48.** Compression attempted, but could not be borne; amputation on third day after admission, and recovery.
- Case 49.** Compression attempted, but could not be borne; amputation performed. Recovery.
- Case 50.** Aneurism cured by compression, in forty hours; on twenty-first day after, sudden rupture of artery above sac; severe local and constitutional symptoms, with acute inflammation of knee-joint, so that amputation was deferred to thirty-third day after rupture. Recovery.
- Case 51.** On seventh day after admission, compression of femoral attempted, and in three days tumour much diminished and the pulse lessened; on seventeenth day, tumour became more diffused; gangrene imminent; left hospital suddenly on fifth week, and returned in two days in a state of intoxication; tumour increased; gangrene threatening; suffering acute; amputation. Result not stated.
- Case 52.** Compression attempted, and could not be borne; ligature of femoral refused; rupture of sac; disposition to gangrene; amputation. Recovery.
- Case 53.** Aneurism attempted to be cured by compression on femoral, and continued for a week with apparent success, when symptoms of rupture and threatening gangrene; amputation. Death on twenty-ninth day, having symptoms of pyæmia.
- Case 54.** Compression for seventeen days; difficult to accomplish, in consequence of bend of knee, and tumour became firmer; digital compression constantly and effectually for ninety-four hours; this was well supported at first, but on following night intense pain in whole limb, lasting three hours; these occurred again on second night, so as to cause him to cry out for pain; œdema of leg increased, and required a bandage from toes upwards; on ninth night after

leaving off compression, violent pains in calf of leg, tension, and œdema of limb; formation of slough over ham; intense fever; amputation; death six days after, with symptoms of purulent infection.

Case 55. Amputation. Recovery. Five months after, ligature of right femoral in Hunter's canal, for the right aneurism, which began to swell and increase in size, and in which, one day, after violent exertion on crutches, he had considerable pain, with increase in size, so as to stretch both hams; ligature came away on eleventh day. Recovery.

Case 56. Amputation, after having first plunged an abscess-lancet into the softest part, without giving issue to any fluid.

Case 57. Exploration with grooved needle, and small quantity of dark-coloured blood escaped; amputation; health gave way, and death in one month.

Case 58. Gangrene rapid; amputation on seventh day. Recovery.

Case 59. Exploration of most fluctuating part about middle of calf, but nothing escaped; by introducing the finger, an abundance of soft coagulum could be felt, occupying a large cavity within; amputation. Recovery.

Case 60. Exploration by lancet, but only a few drops of dark blood escaped; on following day at noon, on moving limb roughly, about one ounce of fluid blood escaped from lancet-wound, unattended with arterial jet, and easily checked by pressure on the limb; fourth day, probe introduced, and passed in every direction without resistance, and without hæmorrhage; amputation; exhaustion. Death.

Case 61. Immediate amputation refused by patient, but seven days after he consented; amputation; secondary hæmorrhage. Death in forty-eight hours.

Case 62. Previous to admission introduction of lancet, and small teacupful of blood escaped. After admission, exploration; dark-coloured blood evacuated, followed on next day by sudden increase; amputation. Recovery.

Case 63. Aneurism punctured by lancet; extravasation; alarming hæmorrhage on third day through wound; amputation; secondary hæmorrhage. Recovery.

Case 64. Aneurism cured by compression; twenty-five days after, rupture, and subsequently bursting through skin in ham; gangrene followed, and arrested at knee; amputation of thigh on fifteenth day. Death.

Case 65. Compression of femoral for aneurism; at end of week pulsation arrested, when sudden rupture; rapid gangrene; amputation three days after gangrene set in; secondary hæmorrhage two weeks after operation. Death.

Case 66. Incision into fluctuating part of tumour; a flow of blood followed, of a dark, grumous, and pitchy character, and on following day a copious discharge of pus. Gradual subsidence of limb to natural state; fifteen days after, sudden arterial hæmorrhage, filling and distending original abscess, and diffusing itself between muscles, and extending through ham to thigh; amputation. Recovery.

Case 67. Ruptured aneurism; rapid gangrene; no line of demarcation; health giving way; amputation on eighth day; violent delirium; secondary hæmorrhage on twenty-first day; ligature of femoral; recurrent hæmorrhage; reamputation. Death ninety-six days after first operation.

Case 68. Ruptured sac following ligature of femoral about second week. Rapid gangrene. Death.

Case 69. Compression of femoral; favorable progression for eight days, when sudden symptoms of sac giving way; ligature of femoral; separation of thread on twenty-sixth day. Recovery.

SUMMARY.—*Cases left entirely alone, 2; 1 recovered and 1 died of secondary hæmorrhage.*

Cases in which an aneurismal tumour was explored.

Case 42. Aneurism punctured by lancet; hæmorrhage; immense effusion; ligature of femoral; gangrene; amputation. Death.

„ **43.** Exploration by lancet; ligature of femoral; alarming hæmorrhage; amputation. Recovery.

„ **45.** Exploration by incision two inches long, as some supposed it to be a diffused abscess; large quantity of arterial blood escaped; ligature of femoral; secondary hæmorrhage; amputation. Recovery.

„ **56.** Exploration by lancet; immediate amputation. Recovery.

„ **57.** Exploration by grooved needle, and small quantity of dark-coloured blood escaped; amputation.

„ **59.** Exploration of most fluctuating part, about middle of calf; nothing escaped; amputation. Recovery.

„ **60.** Explored by lancet; only a few drops of blood escaped; secondary hæmorrhage; amputation. Death.

„ **62.** Explored by lancet; dark-coloured blood escaped; amputation. Recovery.

„ **63.** Explored by lancet; alarming hæmorrhage; amputation. Recovery.

„ **66.** Incision into fluctuating part of the tumour; flow of dark, grumous blood, &c.; hæmorrhage on fifteenth day; amputation. Recovery.

Cases in which compression of the femoral artery was used.

Case 30. Intermittent compression for 134 hours during 20 days. Recovery.

„ **31.** Compression carefully persevered in for 19 days; evacuation of decomposed blood. Recovery.

„ **32.** Employed for two months, when erysipelas attacked the limb; tumour burst externally; no hæmorrhage; exhaustion. Death.

„ **33.** Attended with apparent success, when the artery gave way just above the sac, and burst externally. Death.

Compression ineffectual, and requiring ligature of femoral.

Case 34. Compression six days; increase of swelling; ligature of femoral. Recovery.

„ **35.** Compression and forcible flexure of knee for 13 days; sac burst into knee; ligature of femoral. Recovery.

„ **41.** Ineffectual for five days; badly managed; ligature of femoral; gangrene; amputation. Recovery.

Case 40. Compression with apparent benefit; sudden rupture of sac; ligature of femoral. Recovery.

- „ 38. Could not be borne; ligature of femoral; bursting of sac externally; gangrene. Death.
- „ 47. Compression for four days, and left off for five days, when tumour burst externally; ligature of femoral; gangrene; amputation. Recovery.
- „ 48. Compression attempted, but could not be borne; amputation. Recovery.
- „ 49. Compression attempted, but could not be borne; amputation. Recovery.
- „ 50. Aneurism cured by compression in forty hours; ruptured artery above sac; amputation on thirty-third day after. Recovery.
- „ 51. Attempted compression, and with benefit, when on seventeenth day increase of swelling and threatening gangrene; amputation; result not stated.
- „ 52. Compression attempted, and could not be borne; amputation. Recovery.
- „ 53.¹ Compression attempted for a week, when sudden enlargement and threatening gangrene; amputation. Recovery.
- „ 54. Compression for seventeen days, and digital compression for ninety-four hours; sudden enlargement and pain; amputation. Death.
- „ 65. Compression for one week; sudden increase; gangrene; amputation; secondary hæmorrhage. Death.
- „ 69. Compression favorable for eight days; rupture; ligature of femoral. Recovery.

Cases in which ligature of the femoral was employed. In 9 the limb was not amputated after ligature.

Case 34. Compression for six days, when increase of swelling; ligature. Recovery.

- „ 35. Compression for thirteen days; sac burst into knee; ligature. Recovery.
- „ 40. Compression with benefit; sudden increase; ligature. Recovery.
- „ 38. Compression unbearable; ligature; gangrene. Death.
- „ 36. No previous treatment; ligature; gangrene. Death.
- „ 68. Two weeks after ligature, sac burst; gangrene. Death.
- „ 37. Gradual and slow progress for two or three months; ligature. Recovery.
- „ 39. Sudden; several days ruptured; ligature. Recovery.
- „ 69. Sudden and immediate operation; ligature. Recovery.

In 7 the operation of ligature was performed, but afterwards amputation found necessary.

Case 41. Ineffectual compression, five days; ligature; gangrene; amputation. Recovery.

¹ Dr. Carte and Mr. Tuffnell remark, on Case 53, that the cases, in which the rent occurs on the anterior surface of the vessel, are never successfully treated either by ligature or by pressure on the femoral.

Case 42. Following lancet wound, one day; ligature; gangrene; amputation. Recovery.

„ 43. Exploration; ligature; secondary hæmorrhage; amputation. Recovery.

„ 44. Large aneurism; rupture indefinite; ligature; inflammation and suppuration; amputation. Death.

„ 45. Exploration; ligature; hæmorrhage; amputation. Recovery.

„ 46. Operation declined for eleven days; ligature; gangrene; amputation. Recovery.

„ 47. Compression for four days and omitted five days; bursting; ligature, gangrene; amputation. Death.

In no case was the *popliteal space laid open* in ruptured aneurismal sac; and Porter, in his work, well observes, “If the diffusion has been caused by the bursting of a circumscribed sac of an idiopathic aneurism, it will be more objectionable to cut down upon the injured spot, because there is so far presumptive evidence of the artery not being healthy in that situation, and consequently the risk of secondary hæmorrhage will be greater.”

Cases in which amputation was performed, 27 in all, in 1 of which the result is not stated; 16 recoveries and 10 deaths.

1st set, in which amputation was performed without any previous treatment except exploration. In 13 cases 7 recoveries, Cases 55, 56, 58, 59, 62, 63, 66; 6 deaths, Cases 57, 60, 61, 64, 65, 67.

2d set. Where compression had been previously employed. In 6 cases (Case 51 not stated) 3 recoveries, Cases 48, 49, 50; 2 deaths, Cases 53 and 54.

3d set. After ligature of the femoral had been employed. In 8 cases, 6 recoveries and 2 deaths; of these 3 had previous employment of compression of the femoral, viz., Cases 41, 47, 52, and were recoveries; in 3 there was exploration of the tumour previous to ligature; viz., 42, 43, and 45, the two latter recovering; and in 2 cases, 44 and 46, ligature was immediately applied; one died and one recovered.

We will now review these amputations according to the conditions which demanded amputation.

1st set. Immediate or primary amputation deemed advisable.—In 8 cases 6 recoveries, Cases 49, 55, 56, 59, 62, and 63; 2 deaths, Cases 57 and 60; 75 per cent.

2d set. Deferred or secondary amputation.—19 cases, 1 not stated; 10 recoveries, 57·89 per cent., 8 deaths.

a. For threatening gangrene in 6 cases, the result in one, Case 51, not stated, 2 recovered, Cases 48 and 52; 3 deaths, 53, 54, and 61, the two former from pyæmia.

- b.* For gangrene when fully set in, 8 cases; 4 recoveries and 4 deaths; in 7 it was performed whilst spreading. Cases 41, 42, 46, 47, 58, 65, and 67; and with success in 4, viz., 41, 46, 47, and 58. In one, Case 64, where it was arrested at time of operation, death ensued.
- c.* For hæmorrhage and secondary hæmorrhage in 3 cases, in all of which recovery took place, viz., Cases 43, 45, and 66.
- d.* For inflammation, suppuration, &c., exhausting the patient, 2 cases, one recovery, Case 50; and one death, Case 44.

We will now give the full detail of each case of ruptured aneurismal sac.

CASE 28.—*Ruptured popliteal aneurism; refusal of all operation; bursting of tumour externally; much hæmorrhage; spontaneous cure.*¹

Richard Donovan, æt. 33, a blacksmith, in the month of October, 1796, perceived that his right leg was considerably swelled. The swelling was constantly augmented towards evening; this gradually subsided, and at end of two weeks entirely disappeared. At this time a small circumscribed tumour took place in ham, attended with pulsation, a slight degree of inflammation, and a great deal of pain. About a week after it attained the size of a walnut, and in a month that of a hen's egg. The pain increased in proportion, so that the limb did not admit of full extension or flexion without occasioning excruciating agony. Finding the tumour rapidly increasing, he applied to the Westminster Dispensary, and was recommended to come into the hospital. He procured admission into St. Thomas's Hospital, under Mr. Clive, and an operation being proposed, he left in a few days. The disease progressed, and in February, 1797, it had reached the size of a man's head. The skin over whole extent of tumour greatly inflamed and very tense, and pain almost intolerable. The pulsation was now only to be discovered by pressing firmly with the fingers upon the upper part of the tumour. He now entered St. Bartholomew's, but did not stay long, as an operation was proposed. On the day of leaving the hospital, one of his crutches slipping, he fell to the ground and bruised the swollen knee; on the third day from this he perceived two distinct tumours, each of which was half an inch in diameter, attended with violent pulsation, and situated high upon the course of the femoral artery of left thigh; they enlarged very quickly, and the limb on that side was considerably benumbed. In this condition he was admitted into the Westminster Hospital, under Mr. Lynn.

On the right side there was the large popliteal aneurism, in which, for more than nine weeks, there had not been any pulsation; the leg was benumbed; the skin over the tumour was inflamed and tense, attended with excruciating pain. An oozing of bloody serum had already taken place from the most depending part of the tumour, where the cuticle had burst; and as every moment seemed to threaten the destruc-

¹ 'Trans. of a Society for Improvement of Med. and Chir. Knowledge,' vol. ii. Mr. Wilson.

tion of the patient, a tourniquet was constantly kept in readiness. Having resided seven days in hospital, he insisted upon being removed to his lodgings. The oozing of serum continued for some days after, nor was the pain diminished.

On the 6th of May (nine days from first appearance of serum), when in bed, he had suddenly the sensation of a fluid running down his leg; upon examination, he found that the integuments of the tumour in the ham had given way, and that the blood was rushing out from the wound in such quantity that, in the space of five minutes, four pounds were lost. During this time he fainted repeatedly. On the 8th the wound was become much enlarged, discharging lumps of coagulum occasionally during fourteen days. By this time the knee was nearly reduced to its natural size, and the wound suppurating.

He was now admitted a second time into the Westminster Hospital. The discharge continued copious for fourteen weeks, and varied in appearance according to the state of health of patient. At the end of four months the wound was completely cicatrized; he had a serviceable limb.

The two aneurismal tumours on left femoral were treated by moderate and uniform pressure, made by a flannel roller, continued for two months; they approached so nearly to each other as to form, apparently, one tumour, without any pulsation. Before the patient quitted the hospital (January 10th, 1798) it was so very much diminished in size, as to be scarcely discerned when his breeches were on. It was perfectly soft, and gave no uneasiness. This left extremity is considerably less than its natural size. The right is the most serviceable limb, although it is shorter by two inches, the effect of the mischief in the ham.

CASE 29.—*Ruptured aneurism; difficult diagnosis; exploratory operation refused; apparently recovering; sudden hæmorrhage; death.*¹

Anne Foley, æt. 40, admitted into North Infirmary, Cork, under Dr. Hobart, with tumour behind knee of five months' standing; had suffered intense pain. The tumour rapidly increased in size, and the leg and foot became greatly swollen, the ankle being at one time more swollen than the knee. At one time she fell forward on the floor, as she was trying to hobble through the room; this fall strained the veins, particularly one running up the thigh, which became hard and black. One night she noticed, rather suddenly, a remarkable sensation in the limb, as if the whole swelling was being drawn up from the ankle into the knee.

On admission, the tumour was principally situated above the knee-joint, on the posterior aspect of the femur; a process of it seemed to extend below the knee, deep into the upper part of the calf of the leg; and another upwards along the course of the biceps muscle, nearly half way up the thigh. The principal mass can be well defined in its lower margin, which is round and prominent; above, its extent is not so clearly marked; and laterally, it seems to embrace the entire of the circumference of the limb. On touching it lightly there is no sense of fluctuation, but on pressing heavily with the thumbs, a sensation of deep-seated fluid is communicated. Surface

¹ 'Dublin Journal,' 1858, vol. xxv, p. 443.

smooth and slightly polished from tension of skin; circumference of limb sixteen inches and a half. Complains of desperate pain about the knee. On applying the stethoscope no sound could be heard.

On sixth day tumour explored, blood alone, of dark colour, coming away.

It appears she was in the South Infirmary, Cork, some time back, when the tumour was much smaller; there was no pulsation in it then, and it seemed rather to be an enlarged gland, or some form of encysted tumour.

On ninth day a large trocar and canula introduced, and a free discharge of very dark blood. Supposed to be fungus hæmatodes. Patient refused any operative measures. Decomposition of contents ensued, and a copious discharge of dark, bloody stuff through the puncture, most offensive, and the tumour became greatly reduced in size; suppuration ensued; health affected.

On twenty-fourth day after admission, sudden profuse arterial hæmorrhage set in, and patient died.

Examination of limb.—Large clot occupying ham, quite soft, as if recently formed; on evacuating clots and pus, a round tumour, the size of a billiard ball, was seen lying near the bone; this was tolerably firm at its upper part, where it was whitish, and seemed like partially organized fibrin, but the lower part was soft and dark coloured. On passing a probe down the sound femoral artery, it suddenly stopped near tumour, and on laying open the vessel, a papilla-shaped piece of fibrin was seen protruding into the side of it next the tumour, into which a probe could be freely passed at either side of the papilla. The greater part of the sac was strong; but at the lower part it was dark-coloured and soft. The tumour contained a cavity of the size of a hen's egg, smooth, its lining membrane continuous with that of the artery.

CASE 30.—*Ruptured popliteal aneurism; compression for 134 hours during twenty days; recovery. Subsequent injury and readmission; recovery.*¹

Harriet L—, dressmaker, æt. 23, good general health, admitted into City of Dublin Hospital, under Dr. Hargrave, with enormously diffused popliteal aneurism. She first observed a tumour in the ham four months previously, and it has been constantly increasing. The only cause she could assign for it, was a hurt she received from a door; she was in the act of running out of a room, when some person, in play, forcibly shut the door, and caught the thigh between it and the frame. About a week subsequently to this, she perceived a small tumour, of the size of a marble, in the place where the sharp edge of the door had struck her; this part she now points out as the upper and most prominent portion of the present tumour. It gradually and steadily increased and pulsated. When it became as large as a walnut, the pulsations were so strong as to lift the thigh and leg off, when placed across the opposite one; as the swelling increased, the leg became benumbed, and before admission it was often blue and cold, and slightly œdematous. The whole limb was affected with painful twitchings.

On admission, a large, pulsating tumour was observed to occupy the lower part of the thigh, for six inches above the patella, and extending spirally, backwards and

¹ 'Edinb. Med. and Surg. Journal,' 1851, vol. lxxvi, p. 506.

downwards, as far as the head of the tibia; the exact shape of the tumour could not be ascertained, but it appeared to be irregularly quadrilateral, longer in the vertical than in the horizontal direction; the upper part best defined and most prominent. There was no discoloration of the integuments over it: temperature natural; leg flexed at an obtuse angle on the thigh; outline of the patella lost, and natural shape of the joint destroyed. Three inches above the patella the circumference of the limb was seventeen inches and a half, round the patella sixteen inches and a half; the corresponding parts on the opposite limb measured respectively sixteen inches and a half and fourteen inches and a half. A distinct bruit, best marked in the upper part, was audible all over the tumour, synchronous with the systole of the heart. The tumour could be diminished by making firm pressure on the femoral, *but this diminution was very slight*. Indistinct fluctuation could be perceived. Ice applied to tumour.

Compression commenced on fifth day, but could not be borne for continuance. She was under treatment for twenty days, that is, from the first application of the compression until all pulsation had ceased in the tumour, during which period the absolute pressure did not amount altogether to more than 134 hours, or five days and a half. Some difficulties were encountered; the pressure could not be applied on any part of the thigh, owing to its being full, soft, and flabby, offering no support or counter-resistance to the instrument, unless it was carried to its maximum, to arrest the pulsation in the tumour, and which could not be endured, when tried, but for a very short period; it also caused the aneurism to be more distended, and the limb to be considerably congested. The inguinal region was the only site, which was not very favorable, not only small enlarged lymphatic gland, but the remains of a cicatrix, and very sensitive.

She left the hospital about the eleventh week, the limb natural in size and temperature; a part of the tumour remained unabsorbed and solid.

She was brought into the hospital the night following, in a state of great excitement from intoxication and pain; the limb was greatly swollen from above the knee down to the ankles, and very hot. She screamed violently, and she felt as if her leg had burst, referring to the calf of the leg as giving most pain. It appears, from her account, she had been in the park all the day (Saturday); that she had walked a considerable distance, and jumped across a stream; that she went to the theatre in the evening, and returning from thence drank six glasses of brandy; she remembers nothing further.

For four or five days she suffered much pain in calf of leg, the temperature of which was considerably lower than that of the other leg.

Under the application of a flannel roller, from toes to middle of thigh, and rest, she gradually recovered, and left in three weeks at her own request, the limb being, in function and appearance, as perfect as the other.

CASE 31.—*Unsuccessful treatment by compression forcibly used; sloughing, &c.; parts healed; aneurism gave way; careful and moderate compression; recovery.*¹

Peter Beale, æt. 22, formerly private in 5th Fusileers, stated that during a march

¹ 'Dub. Med. Press,' 1853, vol. xxix, p. 338.

of twenty-three miles over a mountain road in the Mauritius, he experienced a strain (his foot turning in a car track), which was followed in five or six days by a swelling in right ham about the size of a pigeon's egg. He was placed in the hospital on the following day, remaining there nine months. Compression for ten days three inches below Poupart's ligament; a deep slough formed, and cicatrized (cicatrix one and a half inch by one inch); instrument moved to one inch lower down, when a similar slough formed. No effect on tumour.

Returned to England, and remained in Hospital at Chatham five months; here pressure was again tried for thirteen days; the pressure over middle of thigh caused a deep slough, and that over groin a superficial one. When ulcers healed he was discharged, the tumour having rather increased in size.

Admitted six months after latter occurrence, into the Queen's County Infirmary under Dr. Jacob. Within the last three weeks the tumour has increased very much, altogether preventing his walking. He complained of severe pain in the tumour and leg. It extends at present from about three or four inches above the knee on posterior part to the upper part of the middle third of the leg; it measures round *the upper part nineteen inches, the lower part seventeen and a half inches; length of tumour six inches*. The size can be slightly diminished by pressure on the artery in the thigh, but the tumour returns to its original size immediately on its being removed. By auscultation a bruit de soufflet is audible, principally on the outer side, over the head of the fibula, and on the inner side behind the head of the tibia. The tumour extends at each side above and around the condyles of the femur. The knee joint is bent, the leg being nearly at a right angle to the thigh, and cannot be made straight. Was left quiet in bed for twenty-two days; tumour remaining much the same. Compression was now commenced, and limb bandaged from toes to where compression made.

The daily account of the difficulties to be surmounted, the changes taking place in the sac, the formidable complication of pneumonia, low diarrhoea, and phlebitis of the opposite limb, are fully detailed.

Perseverance with compression notwithstanding. Part of the effused blood decomposed, requiring opening, and evacuation of twenty ounces of fetid, grumous blood; one at posterior inferior part of tumour; and another opening on external side below knee. Soon afterwards a quantity of fibrine came away from the opening in ham, having a laminated appearance; the different layers can be separated from each other.

Compression nineteen days; the weight used was eight ounces ten or twelve times a day, gradually decreased to twenty-sixth day. Discharged cured five months after admission; the limb nearly straight, and he was able to walk well.

CASE 32.—*Ruptured aneurism: compression for two months; recovery; attack of erysipelas; bursting of sac externally; no arterial hæmorrhage; secondary attack of erysipelas; death.*

J. B—, æt. 38, admitted October 30th, under Mr. Hutton, into Newcastle Infirmary,

¹ 'Med. Gaz.,' 1852, vol. i, p. 566.

blacksmith, pale, sallow-looking, hard liver and drinker. Right popliteal aneurism of six months. At present, foot and leg, up to above knee, are much swollen and cold. The knee is a good deal bent and fixed. The limb around the tumour measures twenty and three-quarter inches: the opposite limb at same part twelve and a half inches. Compression with Weiss's tourniquet, substituted afterwards for Bellingham's. Continued for two months.

On removal of compression no pulsation in tumour, which is not diminished in size, but has a soft, elastic feel. One month after this, erysipelas attacked limb, which is much swollen. The tumour is soft, and fluctuates. On February 12th, tumour burst, and twelve ounces of dark matter, like coffee grounds, discharged; no hæmorrhage. On 23rd, several portions of firm coagula evacuated.

March 18th, sits up and walks about. 21st, again attacked by erysipelas and difficult breathing. Death on 22nd.

Examination of limb.—Femoral artery previously injected with plaster of Paris. On dissection, femoral artery found injected down to sac; the sac itself filled with injection, lacerated in several places, and injection extravasated into surrounding tissues. Posterior tibial partially injected.

CASE 33.—*Aneurism undergoing cure by compression; bursting of artery above sac; sudden external hæmorrhage; death.*¹

A man, æt. 25, of temperate habits, has been in the army, and undergone much hardship in the Crimea before Sebastopol, and now discharged, admitted under Dr. Murray into Belfast General Hospital. Eight weeks before admission, the formation of a tumour in the left popliteal space attracted his attention; this rapidly increased in size, and ultimately became as large as a cricket ball; foot and leg œdematous. On the third day compression employed. After twelve days' use the pulsations in the ham were very much lessened; in fact, not more than distinctly perceptible; at the same time, the tumour was quite hard, and of its original magnitude. The œdematous condition of the foot and leg now became extremely troublesome (a pulsating tumour was also now noticed at the upper extremity of the sternum). On fifteenth day impulse scarcely perceptible, and on seventeenth day circulation could no longer be detected. On twenty-first day, several bullæ, which had formed on instep, on different parts of leg and popliteal region, burst, and a large quantity of serum, tinged with blood, passed from the limb; more or less continued to ooze from various points for the next six days. On the evening of the twenty-seventh day the case terminated fatally, with extreme rapidity, in the following manner: During the evening he had been restless and fretful; after remaining perfectly quiet for a short time, he screamed for the nurse, who ran to his assistance, and found his bed deluged in blood; he gave a few long-drawn inspirations, and ceased to live.

When the body was being removed to the dead-house, a large cyst was observed hanging loosely from a jagged, irregular cavity in the ham; it was seven ounces in weight, and of firm consistence; the lower part of the popliteal artery could not be traced in it, but at its upper or proximate end, a portion of vessel, one inch and a half

¹ 'Dublin Journal,' vol. xxiv, 1857, p. 451.

long, was found; its upper margin was sharp and well defined, as if cut with a knife.

Permission to examine the body refused.

It was evident from the atheromatous condition of the artery, that death had been caused by rupture of the diseased coats above the site of the aneurismal tumour, and that the extravasated blood had dissected the hardened mass which constituted the clots.

Query.—Had not artery given way as early as seventeenth day, or even before that, producing the troublesome redness, and the condition of the integument observed on the twenty-first day.

CASE 34.—*Ruptured aneurism; compression for six days; ligature of femoral; protracted recovery.*¹

Private Thomas Brown, æt. 32, six foot, powerful, muscular; dissipated habits, under care of Dr. Mitchell; he stated, that he had been troubled with pain in left popliteal space for twelve months, but it was not until after a field-day on March 28th, that he observed any tumour; the pain at this time underwent an aggravation. The pulsation, when aneurism first discovered, was more distinct than it became within a few days, the swelling was smaller and better defined, and expansion on pulsation more general and forcible.

On admission into hospital, Plymouth, on 30th, there was a large, diffused, hard swelling on inner side of left popliteal space, extending half way up thigh, and round to inner and fore part of thigh, but not ascending so high in this direction. The swelling at every part had a pulsatory movement, synchronous with pulse; arrested by compression of femoral, when slight subsidence of swelling observed; whizzing sound heard by stethoscope; great pain in site of tumour; slight swelling of leg; pulsation of tibials, weak.

Compression for six days. Ligature of femoral in consequence of increase in size of swelling, and no diminution of pulsation; leg and thigh became much swollen; ligature did not come away for five months; protracted recovery. Rejoined regiment with hardly a vestige of the tumour; limb rather weak.

CASE 35.—*Aneurism treated by forcible flexure and compression for thirteen days; failure; rupture into knee-joint; ligature of femoral; recovery.*²

Navigator, æt. 46, fine manly, highly nourished, admitted into the Middlesex Hospital under Mr. Moore with very large aneurism in right ham five and a half inches long, of six weeks standing, without any particular cause.

Treated by flexure of the limb; in addition compression; continued for thirteen days, when knee found to be altered in shape, and patella raised on loosing tourniquet; pulsation in joint; filling and emptying as pressure made on artery. Aneurism had burst into joint. Ligature of femoral came away on twenty-first day; recovery.

¹ 'Med. Times. and Gaz.,' 1853, vol. ii, p. 648.

² 'British Med. Journal,' 1859, p. 479.

CASE 36.—*Ruptured aneurismal sac; extensive extravasation; ligature of femoral; gangrene; death.*

J. H—, æt. 30, male, admitted under Mr. Key, at Guy's Hospital; popliteal aneurism of six weeks; noticed a numbness in leg two years. Four days after admission great increase of size; on fifth day alarming swelling; integuments tense, and slightly discoloured; limb twice size of opposite; swelling reached to groin; and integuments of yellow tinge; parts below knee natural; very little feeling in parts; limb heavy. Bursted sac. Femoral artery tied. In evening temperature rather higher than natural; pulse 80, and feeble, and kept up next day. Second day after operation, pale, anxious, muttering, hiccough, vomiting, hot skin, pulse 120, tongue dry, dark brown; temperature of limb diminished; limb was tense, pale, œdematous. In the evening temperature much less; coldness extending from foot up the leg; cuticle beginning to separate; hot flannel and warmth. Third day foot more discoloured; three large vesications filled with dark coloured fluid in foot and ankle; toes cold, and of dusky hue. Thigh remains swollen, and retains its natural heat. Tongue brown; hiccough; pulse feeble, 108. Fourth day, pale, cold perspiration; coldness increased; vesication more distended. Seventh day, thigh somewhat decreased; hiccough ceased; perspiration continues; foot gangrenous. Tenth day much weaker, cold sweats: gangrene not extended. Died on twelfth day. No examination of limb.

CASE 37.—*Ruptured aneurism from violence; slow and gradual extravasation; ligature of femoral at eighth week; recovery; ligature of opposite artery for aneurism successful.*¹

James Brady, æt. 38, strong, healthy; formerly infantry soldier. Admitted Nov. 1833, under Mr. Collis, Surgeon to Meath Hospital.

In the year 1818 he felt a pain in both hams, and soon after perceived a tumour in each popliteal space. These became somewhat larger when exposed to fatigue or cold; from the commencement a throbbing was felt in the tumours, but the patient was never prevented from attending to the duties of his occupation. These tumours continued stationary until August 1833, when his right leg was much and severely bruised between two cows, whilst employed as cattle driver. The tumour in this limb shortly after increased and became painful; the throbbing augmented. The leg and thigh became swollen, and the foot numb and cold.

He came to the hospital in this state six weeks ago, but refused to remain in the house at that time. He shortly resumed his labours, and exercised his limbs considerably; the tumour soon increased; his leg and foot became swollen and œdematous; he complained of numbness and a want of sensibility in the limb. The tumour in the ham became more diffused, and the pain and an uneasy sense of constriction in the limb deprived him totally of rest. In this state he was admitted; the veins upon the surface of the limb very distinct; a slight erysipelatous blush over the inside of the knee; pulsation much diffused over the tumour; general health but little affected.

¹ 'Dublin Journal,' vol. v, p. 29.

He was kept quiet in bed; pain diminished, and external inflammation subsided, but the tumour became daily more tense and extended; ligature of femoral on tenth day; recovery.

One month after above operation, ligature of femoral for left popliteal aneurism, which had all along remained of same size. Recovery.

CASE 38.—*Ruptured aneurism; burst externally; ligature of femoral; gangrene; rapid death.*¹

A Chinese, æt. 56, a cake-maker. Admitted into hospital at Canton, under Dr. Hobson, for popliteal aneurism of two months' duration. The tumour occupied a large extent of surface, and was rapidly increasing; the leg was œdematous, and he complained of pain. The tumour beats strongly, and is hot and painful; pressure could not be borne; it was arranged to tie the femoral after he had received the sanction of his friends. On the third day it had much increased, red and much more tender, and the skin exceedingly thin. A tourniquet was lightly applied, in case of any accident; in the evening the aneurism suddenly burst, and blood projected to a great distance; about two pounds of blood were lost. Ligature of femoral immediately performed. Gangrene set in on the fourth day, but he was so low as to preclude all hopes of amputation. Death on fifth day.

CASE 39.—*Ruptured aneurism; ligature of femoral; recovery.*²

Jeremiah Tomkins, æt. 35, a labourer in the coal trade, and accustomed to drink freely. Admitted into University College under Mr. Quain. About five weeks previously he first noticed a swelling towards the inner and back part of the thigh, at about the junction of the middle with the lower third of this part of the limb. It throbbed and was tender, notwithstanding which he did not desist from work until a fortnight before his admission. The swelling continuing to increase, he now felt pain in his knee, extending down the back of his leg to the ankle and foot, and also up to the hip. Three days ago, he observed an increase in the swelling of the parts about the knee, especially in the popliteal space, but extending down to the ankle and foot, and attended with numbness and inability to move the leg.

On admission, in the popliteal space, or rather just above this and over the course of the femoral artery, was a hard, firm, moveable mass, discoloured over a portion of its surface, and marked by enlarged superficial veins. The patient experienced throbbing pain in it; the leg was considerably swollen, the foot benumbed, and the knee, which was stiff, was the seat of a pricking sensation. The patient, before his entrance into the hospital, had been salivated, on the supposition that his complaint was rheumatism. The case was ascertained to be a secondary diffused aneurism. The original circumscribed aneurism was situated at the commencement of the popliteal artery; and the swelling of the limb below this point, and especially in the popliteal space, had augmented very much during the last two days. The tumour, which was tender and painful on pressure, could be felt with the hand to

¹ 'Med. Times,' vol. xx, p. 288.

² 'Med. Gazette,' vol. xxviii, p. 234.

be attended with a weak pulsation in it; there was some little discoloration of its surface. When the leg was touched or pinched, the patient was scarcely conscious of what was done, so great was the degree of numbness in it.

Femoral artery tied in upper third. Ligature came away on seventeenth day. Recovery.

Remarks by Samuel Cooper.—Directly I placed my hands on the swelling, its solid feel at once made me certain that the case was not an abscess; also the history of its throbbings in the early stage; its sudden increase when it became diffused, and the reduction in the force of pulsations, accompanying this latter very important change.

The sensation imparted to the surgeon's hand, when it was applied to the swelling at the moment of pressure being removed from the artery in the groin; for then the fresh and sudden rush of blood to the tumour could be distinctly perceived in it, leaving no doubt of the swelling arising from and communicating with the artery.

CASE 40.—*Ruptured aneurism; ligature of femoral; recovery.*¹

A man, æt. 36, admitted into Guy's Hospital under Mr. Birkett, had discovered the swelling in the ham only three weeks, and had never had any pain or rheumatism. Pressure was applied for four weeks, with apparent benefit, when the tumour suddenly enlarged, and the sac had, without doubt, given way. There was at first distinct pulsation, but this gradually became weaker. A ligature on the femoral was at once applied; on the ninth day it came away, and convalescence ensued, &c., &c.

CASE 41.—*Aneurism; ineffectual compression; rupture of sac; ligature of femoral; gangrene; amputation; recovery.*²

B. W—, æt. 34. Strong, healthy. Admitted with popliteal aneurism of eleven weeks' duration, into Norwich Hospital, under Mr. Norgate. Size of small hen's egg; ineffectual attempts at compression, badly managed, for five days; then rapid increase in size; patient writhing with pain all over knee, ham, and leg; coldness of foot. Tumour extended up inner aspect of thigh to two inches; general pulsation; very slight œdema of leg.

Ligature of femoral; gangrene followed; amputation; recovery.

Examination of limb.—Aneurism of globular form, five inches by four; rupture thereof; extravasation under knee and integuments; pressure on sural vessels and

¹ See 'Guy's Hospital Reports,' Series III., vol. vi, p. 63.

² 'Dublin Med. Press,' 1851. Lancet.

the articular ; veins and nerves subject to great pressure, and lying in a groove of the tumour.

CASE 42.—*Aneurism, punctured ; diffused and extravasated blood ; ligature of femoral ; gangrene ; amputation ; death.*

A farm labourer, æt. 25, admitted into Guy's, under Mr. Callaroy, who three months previously discovered a pulsating tumour in his right popliteal space, his attention having been drawn to the spot by a pain shooting down the leg. He continued, however, at his work for one month, when he sought advice. He was directed to apply a poultice to the part ; and as this gave no relief, a puncture was made into it with a lancet ; nothing, however, then escaped, but the following day some hæmorrhage coming on, he was sent to Guy's Hospital with a tourniquet on his femoral artery. When admitted, the whole of the popliteal region and leg was swollen with extravasated blood, and had no pulsation in it whatever, nor did the history of the case correctly reveal its true nature ; a ligature was at once applied to the femoral artery. Gangrene, however, rapidly followed the operation, and on the twelfth day amputation was performed ; and twelve days subsequently the man died from exhaustion.

On examining limb, an enormous diffused aneurism, the whole tissues of leg and thigh infiltrated with blood, causing pressure on the venous circulation of limb.

CASE 43.—*Ruptured aneurism ; difficult diagnosis ; explored by lancet ; ligature of femoral ; hæmorrhage ; amputation ; recovery.*¹

Related as one of similar nature to Case 36. Tumour of considerable size, and without pulsation ; no accurate history ; (? abscess or blood) ; opened by lancet, or diagnosis ; blood escaped ; aperture closed ; artery tied in middle of thigh.

On following day tumour unreduced in size, and as tense as before the operation. Hæmorrhage from wound, increased to alarming extent ; patient sinking ; amputation performed ; recovery.

CASE 44.—*Large aneurism ; time of rupture indefinite ; ligature of femoral ; progress towards cure ; erysipelas ; suppuration about sac ; three abscesses communicating with sac, one of which entered knee-joint ; amputation of limb ; death.*²

James Ferguson, æt. 30, sailor. General health good. Admitted with popliteal aneurism in left ham of eight weeks' duration, under Mr. Allan, Royal Infirmary, Edinburgh. It formed an elastic circumscribed tumour, which was so large as not only to fill up, but to project beyond, the space defined by the hamstrings, and which afforded to the touch a distinct thrilling sensation. The integuments above

¹ Chirurgus of Plymouth, in the 'Lancet' of Nov. 1824.

² 'Edinburgh Journal of Med. Science,' vol. i, p. 331.

the tumour were tense, but not red or painful. The pulsation of the femoral artery was strong, but that of the anterior and posterior tibial arteries indistinct. The motions of the knee-joint were much impaired, and he kept his leg continually in a semi-bent position. He experienced at times in the leg severe shooting pains. There was occasional œdema, and a tingling sensation in the foot.

Three days after admission, ligature of femoral. From this time up to tenth day went on favorably, when he felt considerable pain, extending up the leg towards the wound, with some starting; a blush of inflammation around wound; some febrile disturbance, succeeded by erysipelas and constitutional irritation; he also complained of pain about the knee, attended with burning heat, but no swelling. The tumour had diminished to size of duck's egg. For a fortnight he continued feverish, and the pain in the knee increased, attended with swelling and great heat.

On thirty-third day after operation, the aneurismal tumour felt very soft, and there was a distinct sense of fluctuation round the joint. Two small incisions were made at the most distinct fluctuating points, from which bloody matter was discharged. On the following day several ounces of pus were discharged. Suppuration appeared to be within the joint; irritative fever; health declining. Amputation. Death eight days after.

Examination of limb.—The popliteal vein and nerve were seen running over the external or posterior part of the tumour; the vein was found obliterated. The tumour lay fairly in the hollow behind the condyles of the femur. Upon opening the tumour it was found filled with loose, coagulated blood, and the artery was seen entering its upper and passing out at its lower part. The points at which the artery entered and passed out were situate towards the outer side of the sac, and were two inches apart; both of the openings within it had smooth, rounded edges; the upper one was of the size of goose-quill, and the lower one that of crow-quill. No laceration of the internal coats of the artery could be perceived, but it looked as if all the coats on the side next the knee-joint had been dilated. Upon further examination three distinct abscesses were discovered, all of which were deep-seated and communicated with each other. The largest was situated between the aneurismal sac and the inner hamstring, and was bounded by the bone and capsule of knee-joint; betwixt it and the aneurism there were two openings, each of which would admit the point of the little finger. These openings were at the inner side of the sac, about its middle, and coagulated blood was seen projecting from one of them into the abscess. Another abscess, about half the size of former, occupied the situation of popliteus muscle in connexion with external condyle; it opened into the knee-joint at its outer side. The third abscess was on the fore part of the femur, immediately above the knee, and exterior to the capsule, and it communicated laterally with both the other abscesses. Pus was contained in the cavity of the knee-joint.

CASE 45.—*Ruptured sac; exploration; ligature of femoral; secondary hæmorrhage; amputation; recovery.*¹

J. B—, stonemason, æt. 30, admitted into Westminster Hospital, under Sir A. Carlisle. Three months ago first perceived swelling in ham, about size of walnut,

¹ 'Lancet,' December, 1826.

attended with pain and pulsation. Leg soon began to swell, but not rapidly, and then the pulsation ceased.

On admission, leg twice its natural size, exceedingly tense, and of dark-brown colour, with sense of fluctuation; countenance pallid; pulse 120, very weak. On third day tenseness increased; limb measured half inch more around calf; not much pain. Consultation held—Sir A. Carlisle thought it was diffused abscess; Messrs. Lynn and Guthrie, aneurism. It was determined to wait.

On seventh day, leg larger; more discoloured and tense; exploration; incision of two inches; large quantity of coagulum escaped, and then arterial blood. Femoral artery tied at usual place; coagulum removed by finger; flow of arterial blood from lower part of wound ensued; amputation at once performed; patient going on well.

Examination of limb.—Aneurismal sac lower than usual; anterior and posterior tibial and femoral arteries passed out from sac; extravasation of blood down leg.

CASE 46.—*Ruptured aneurismal sac; operation declined for eleven days; ligature of femoral; gangrene; amputation; recovery.*¹

Mr. Lucas, æt. 48, private patient of Mr. Samuel Cooper; an organ-builder. A large, robust man, of gouty habit. Extensive tumour occupying ham, and extending over sides of condyles of femur towards patella, and reaching under the gastrocnemius. Pulsations remarkably strong, and equally manifest both to sight and touch. Integuments of back part of it were at one point somewhat red and inflamed, foot torpid, and limb from knee downwards of great size, from effects of œdema.

The disease existed five years without suspicion, the patient considering lameness to arise from gouty or rheumatic affection of knee. He had continued to follow his trade up to the present period.

Operation of ligature of femoral urgently advised. Patient desired its postponement for a week or ten days, until he had completed some urgent business. Three or four days afterwards he was severely attacked by gout in right foot and both wrists, which lasted two weeks, and on its subsidence *the throbbing of the aneurismal tumour had diminished considerably, without alteration in appearance of swelling and limb, except a slight purple discoloration above inner malleolus*, somewhat resembling an ecchymosis. Numbness of foot ensued. Five days after this period the foot became all on a sudden extremely cold; no sensibility in toes, but some at ankle and instep; no pulsation whatever in swelling, and no material increase in swelling of leg. Consultation with Mr. Lawrence. By direct auscultation bellows-murmur heard; hence still a current of blood in aneurismal sac; foot and lower part of leg warm.

Operation of tying femoral again urged, but declined. Two days after this, risk of gangrene not lessened; tumour as tense and large as ever; swelling of whole leg undiminished; bellows-murmur still audible; apparent return of natural heat from use of hot fomentation, and frequency of pulse increasing. Femoral artery tied;

¹ 'Med.-Chir. Trans.,' vol. xvi.

fifth day after operation gangrene supervened; pulse 130; restlessness and anxiety; skin of portion of leg black and livid.

Amputation; bone sawn through an inch and a half below ligature of femoral.

From this time everything went on favorably, and in course of six weeks patient recovered.

Examination of limb.—Sac of unusual size; lower and most deeply seated part of sac under gastrocnemii had given way, blood finding its way under gastrocnemius as far as heel.

CASE 47.—Popliteal aneurism, one year; gradual compression, four days; rupture of sac; ligature; gangrene; amputation; cure.¹

William Lawrence, æt. 36, tailor, in bad health. On admission, under Mr. Jolley, tumour occupied whole of popliteal space; compression for four days. Dark spot appeared on tumour, and leg very œdematous; sac burst. Ten days after admission (five days after leaving off pressure), lost one pint of blood. Hæmorrhage on following day; much exhaustion; ligature of femoral on fourth day from first bursting; amputation declined; six days after, gangrene set in, and, on following day, amputation. Recovery.

Examination of limb.—Twice natural size, livid, gangrenous.

CASE 48.—Ruptured aneurism; rapid enlargement; burst into knee; amputation; recovery.²

John Flood, æt. 50, admitted into Richmond Hospital, Dublin, under Mr. Adams. A man of colour, born at Vincenty, has spent his life much at sea. The greater part of the time of his last voyage he was unable to get out of his berth, in consequence of his having a swelling in his right ham. It appeared about four months ago, but became painful and large two weeks back. He was admitted into the hospital a few hours after the ship's arrival.

The popliteal tumour felt remarkably tense, and was tender to the touch, and shining, and upon a superficial examination no pulsation could be felt in the tumour; but when firm pressure was made for some moments by the fingers, these last had a movement and impulse communicated to them corresponding to the patient's pulse; when the stethoscope was applied with some pressure on the swelling, a distinct, but rather muffled, *bruit de soufflet* was audible. When the femoral artery was compressed, all pulsation and *soufflet* ceased, the shining tension of the skin lost, and the popliteal swelling flaccid and soft. There was no pulsation to be felt at any time in any of the arteries of the limb below the popliteal. The leg and foot, as well as the knee, were œdematous. The knee-joint was greatly enlarged. He complained of severe pain in the posterior part of the tumour, and extending thence down the limb.

Compression endeavoured to be attempted, but could not be borne. On the third day the tumour seemed more tense and hot, and two ecchymosed patches appeared on the inner aspect of the tumour.

¹ 'Monthly Journal of Medical Science,' 1847, vol. vii, p. 903.

² 'Medical Times,' vol. xix, p. 268.

Amputation on third day, performed under chloroform. Recovery.

Examination of limb.—Some blood effused under the integument, and derived from an opening about size of shilling on the inner side of the aneurismal sac. The sac was nine inches long and five broad, and had ranged along its posterior and central part, the internal popliteal nerve, and the external popliteal also. Here also were the popliteal artery and vein. The aneurism had sprung from the front of the vessel, and the communicating aperture was an inch and a half long. The aneurism had burst through the posterior ligament into the knee-joint, which latter was full of congealed blood and serum.

CASE 49.—*Ruptured sac ; compression could not be borne ; amputation ; recovery.*¹

W. B—, admitted into Royal Berkshire Hospital, under Mr. Bulley. Stated that, eleven months previously, after carrying a heavy sack of wheat up some steps, he experienced a tingling sensation in front of right knee, and noticed a small swelling in ham ; these symptoms disappeared in a few days. Nine months after this he again noticed the swelling, and that it throbbed, accompanied with pricking sensations up the thigh. From this time it gradually increased, reaching size of pigeon's egg. On the morning of his admission he was engaged in hoeing turnips ; he felt something give way in the ham, and experienced rushing sensation down the leg and up the thigh in the course of the femoral artery. The limb became disabled, and the leg and foot numb and cedematous. The popliteal swelling rapidly increased in size.

Pressure was attempted, and could not be carried out.

Amputation performed. Recovery.

Examination of limb.—Large quantity of extravasated blood under gastrocnemius and in popliteal space. Longitudinal rent in small aneurism, connected with popliteal artery.

CASE 50.—*Aneurism, cured by compression in forty hours ; rupture of artery above sac twenty-one days after ; severe local and constitutional symptoms ; amputation deferred to twenty-third day ; recovery.*²

Soldier, æt. 25, admitted into the Military Hospital, Dublin, under the care of Dr. Clayton. A popliteal aneurism, of the size of an orange, only noticed for two weeks, was cured in forty hours by compression. About twenty days afterwards, the tumour was reduced from the size of an orange to that of an egg ; it was very hard and indolent, without pulsation. The knee became flexible, and all affection disappeared. On the following day the artery burst suddenly above the tumour ; a vast effusion, of a diffused character, immediately took place. The countenance became desponding, the patient irritable and anxious. The whole ham was distended, there was forcible pulsation, and the tumour larger than ever, and there was no assignable cause. The measurement of the right knee was fifteen inches and a half, that of healthy knee thirteen inches. There was increase of the local and constitutional symptoms, which was rapid ; acute inflammation of the knee-joint ensued, as

¹ 'Association Medical Journal,' vol. i.

² See Tuffnell 'On Aneurism,' p. 125.

also œdema of the leg; the integuments assumed a crimson blush, attended with great pain down the leg, rigors, &c. Amputation was performed on the twenty-third day after the accident, and recovery took place.

On examining the limb, the muscles of the calf were dissected by the blood; the tibia and femur exposed, but there was no communication with the joint; there was a solid aneurismal sac, of the size of a pullet's egg, consisting of a mass of fibrine, situated at junction of middle with lower third of vessel; the ruptured artery was just above it. The limb was eight inches in circumference, the leg œdematous, and the lesion consisted of a large, diffused aneurism, occupying the whole of the space; the rupture occurred on the anterior surface of the artery, under the gastrocnemius and hamstring muscles, at the bend of the joint.

CASE 51.—*Ruptured aneurism; compression of femoral; favorable for sixteen days, when increase of tumour and threatening gangrene; left hospital suddenly, and returned intoxicated on second day; amputation; result not stated.*¹

Coal-porter, æt. 28, admitted into Meath Hospital, under Mr. Smily. Two years previously he received a hurt in the knee, and six weeks before admission got a blow of a stick on the ham. To the latter injury he paid no attention, but continued his usual employment, and with this limb dug out a large ship-load of coals. He followed his business, and at the same time continued his irregular course of life, drinking large quantities of whisky, sometimes as many as twenty glasses in a day. He was first seen at his lodgings, in a state of intoxication, and next morning sent to the hospital. So reckless was he and regardless of injury, that he did not apply for any assistance till two days before admission, and the ham was then swollen to a great size, and the entire popliteal region filled up, and he stated that it had been so nearly from the time that he got the blow.

On admission, February 18th, the leg was in a very morbid state, the veins turgid, the limb livid, and the patient in a very bad condition for any treatment. He was kept quiet, and evaporating lotion applied for seven days. March 3d, the compression of femoral attempted. On third day tumour was much diminished and impulse lessened, but patient suffered much pain. He went on favorably for the following sixteen days, till March 19th, when he complained of severe pain during the night, and on the next morning the tumour was found more diffused and the limb swollen and congested. He now suffered intensely, and on 22d of March vesication formed on ankle and leg; gangrene feared. On 24th he suddenly left the hospital, but returned on 26th in state of intoxication. The limb, strange to say, was not in a worse condition than at first, the stimulant having conduced to favour the circulation.

The tumour went on increasing, and on April 5th the blood came quite near the skin, which was discoloured and corrugated, and tightly stretched over the blood. The tibia was pushed forward, and there was effusion into the joint; the skin covering the tumour was thin, and threatened to break; and so distended and red were the veins, that gangrene was momentarily expected. Patient's sufferings very acute, so much so that he became delirious.

Amputation performed.

¹ 'Dublin Hospital Gazette,' 1856.

Examination of limb.—Although considerable effusion into knee-joint, it consisted of synovial fluid only. The original sac size of hen's egg. Sac had given way posteriorly.

CASE 52.—*Aneurism ; compression not able to be borne ; ligature of femoral refused ; bursting of sac ; threatening gangrene ; amputation ; recovery.*¹

James W—, æt. 36, joiner, weak and delicate, predisposed to phthisis. Admitted into the Liverpool Workhouse, under Mr. Leather, with popliteal aneurism of eleven months' duration. It was of size of goose's egg. His health was very much impaired, and there was a good deal of constitutional disturbance. Compression attempted, and could not be borne. Ligature of the femoral was ultimately refused. After several days, there occurred a sudden increase both of pain and swelling, the latter becoming diffused. The pain became most agonizing about the knee and leg. Œdema of leg and foot supervened ; diminished sensation ; reduction of temperature, manifesting disposition to gangrene.

Amputation performed. Recovery.

Examination of limb.—Immense quantity of effused blood under the integuments and in whole of popliteal space. Coats of aneurism found very thin and in some parts quite transparent. The upper portions of the posterior tibial and peroneal arteries were greatly dilated and sacculated, and lower down atheromatous deposit was detected.

CASE 53.—*Ruptured aneurism ; compression for one week, with benefit ; rupture of sac ; increase and severity of local symptoms ; threatening gangrene ; amputation ; death from pyæmia.*²

Labouring man, æt. 65, admitted into Meath Hospital, under Dr. Collis ; looked much older ; hair perfectly white ; addicted to intemperance. About three months previous to admission, whilst going down stairs, his foot slipped, and he felt something give way in the back part of his leg. He recovered from the effects, and continued his work until three weeks ago, when tumour in ham enlarged in bulk, and painful.

On admission, there was a popliteal aneurism filling lower half of popliteal space. After the lapse of a week, pressure was commenced. Mechanical pressure by various apparatus, and by carefully adjusted weights, was tried, and even digital compression was attentively and patiently persevered in for upwards of a week. The effect of this at first seemed to cause a coagulum to be formed in sac. The pulsation in the sac became decidedly less distinct ; and on its outer side (after the lapse of five days' continuous pressure) a distinctly pulsating vessel was discovered, presenting all the indicative characters of a collateral arterial channel. But now the man complained of severe pains in the limb, while the tumour had become more firm and solid to the touch. The limb also became greatly engorged, and the foot œdematous ; vesication began to appear on the dorsum of foot, not of a gangrenous cha-

¹ 'Med. Times and Gazette,' vol. xxxviii, p. 139.

² 'Dub. Hosp. Gaz.,' 1859.

racter. These symptoms gradually increased—viz., solidity of tumour, engorgement of limb, and lessening of pulsation—continuing for a week, when at last the limb became enormously engorged, the skin presenting a mottled appearance, whilst the foot had become swollen out of shape, and the integuments distended almost to bursting with effused serum. Amputation performed. Death on twenty-ninth day. Symptoms of pyæmia.

Examination of limb.—Large quantity of extravasated blood effused under the gastrocnemius and soleus, extending to the ankle-joint; enormous deposits of black clots of recently effused blood, and a mass of coagula in various stages of fibrinous organization.

Original aneurismal sac of size of goose's egg, and seated below joint. The rupture of the artery had taken place at a point about one inch from its bifurcation, and had its seat on the anterior aspect of the vessel. The main artery ran along the outer side of the tumour; it was this which gave the sensation of a large vessel, apparently developed in this situation. Interior of aneurismal sac found lined with lymph, so highly organized as to be with difficulty separable or distinguishable from proper inner coat of artery. It was only in some places, where this coating of lymph was less dense, that it could be detached, and its adventitious character detected.

The sac had given way at first on its upper surface, and had become diffused, the blood escaping into the areolar tissue of the popliteal space. The blood had there dissected its way slowly under the muscles down the limb.

With reference to the above case, Dr. Carte and Mr. Tuffnell remark that the cases in which the rent occurs on the anterior surface of the vessel are never successfully treated, either by ligature or by pressure.

Mr. Tuffnell also observes that all cases in which the *anterior* wall gives way, the tumour has its seat more on the *inner* side of the limb.

CASE 54.—*Diffused aneurism of left ham, communicating with knee-joint; compression of femoral; then digital compression, ninety-four hours; amputation; death.*¹

Louis Pauger, cultivator, æt. 32; accustomed to drink much cider, coffee, and brandy; vigorous constitution; excellent health. For six weeks felt a swelling in left ham, but continued work for a month, when limb swelled and became painful; it increased rapidly, and he came to Paris, and was admitted into the Clinical Hospital, under M. Nelaton.

An aneurism occupied left popliteal space, soft and fluctuating, of size of fist, pulsating; *bruit de soufflet* only heard at upper and inner part. Left leg œdematous from toes to knee. Limb in semi-flexion, and could not be extended. Large effusion into synovial membrane of knee, fluctuating, but no pulsation whatever. Posterior tibials feebly pulsating.

Another aneurism occupied right ham, size of egg; indolent. This was left alone.

¹ Broca, 'Anévrismes et de leur Traitement,' p. 766, Case 45.

Compression for seventeen days; difficult to accomplish, in consequence of bend of knee. Opium during whole time.

Tumour had become a little firmer, and evidently some clots had formed. Digital compression was now made, and kept up constantly and effectually for ninety-four hours; it was well supported for first day, but on following night he had intense pains in whole limb, lasting three hours; these occurred again on the second night, so as to cause him to cry out for pain, and had a short access of delirium. The oedematous enlargement of the leg made notable progress, and in order to modify it a bandage was applied from toe to knee.

At end of the digital compression (ninety-four hours) the tumour was entirely deprived of pulsation, solid, knotty, less projecting behind, but much larger at its upper part; at the side of the knee pulsation very manifest. No *bruit de soufflet*.

Was now left at rest for five days; had passing pain in leg, lasting only half an hour. The pulsation diminished daily, but the tumour did not lessen.

On the ninth night after leaving off digital compression very violent pain in calf, and in morning, intense fever; acute pain; slough of size of five-franc piece over popliteal tumour. Leg, considerable tension and oedema.

Amputation performed. Death on sixth day, with symptoms of purulent infection.

Examination of limb.—Aneurism much larger than supposed, entirely filling and distending popliteal space. Blood-extravasations in sheath of semi-membranosus and under fascia down calf; mass of effusion between artery and joint. Sac at inferior and posterior part of artery capable of containing a nut; ruptured in front, thus forming a fresh tumour of blood, lying between artery and knee-joint; there was a fusiform dilatation of lateral part of popliteal artery. Knee-joint full of blood and red clots, communicating by three small, rounded openings through posterior ligament. Bone not exposed.

Popliteal vein completely obliterated.

CASE 55.—*Ruptured aneurism on left side; amputation; recovery. Right aneurism, after exertion, increased in size; ligature on artery in Hunter's canal; recovery.*¹

William Spencer, æt. 32, admitted under the care of Mr. Joseph Harris, of Whitehaven Hospital; corporal in Cumberland Militia; tall, muscular.

He had a firm, inelastic swelling, extending from middle of left thigh down to the toes, and attended with most excruciating pain. He gave the following account of his case:—Fifteen months ago he wore, for two months together, a pair of tight leathern breeches, which made his legs swell and become so painful that he was obliged to leave them off. About one month after this, after walking ten miles on a very hot day, he felt uneasiness in hams of both legs; in the course of the night observed a swelling in each ham, that of left pulsating. This left one gradually increased until it had diffused itself, and attained present condition. The right aneurism is of the size of a nutmeg.

The left leg was amputated. Recovery.

Examination of limb.—Eleven pounds and a half of coagulated blood diffused among muscles. Aneurismal sac in ham had burst.

Three months after amputation right aneurism began to swell and increase in size,

¹ 'Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge.'

and one day, after violent exertion upon crutches, he had considerable pain in it, with increase, so as to stretch both hamstrings; there was also diffused swelling over knee-joint.

Hunter's operation performed. Ligature came away on eleventh day. Recovery.

CASE 56.¹

A middle-aged man was received into St. Bartholomew's Hospital, under Mr. Lawrence, with a large tumour filling up the whole ham, and extending on both sides of the femur towards the front of the limb. It had begun behind; had existed for five months; had grown latterly with great rapidity, and manifestly increased during a few days, for which we had the opportunity of observing it in the hospital. It had a firm, fleshy feel, being a little softer at one of its anterior protuberances than in other parts. It gave him great pain, though it was not tender on being handled; it had caused considerable œdema of the leg and foot, and had rendered the limb completely useless. The surgeons of the hospital in consultation on this case, viewing it as a large and rapidly increasing fleshy tumour, determined that amputation of the limb was the only remedy that could be proposed. This I performed high up, having first plunged an abscess-lancet into the softest part of the tumour, to the whole depth of the blade, without giving issue to any fluid.

The examination of the amputated limb disclosed to us the very unexpected circumstance that this tumour was a popliteal aneurism, containing an immense mass of firm, bloody coagulum, not of that light-brown laminated kind which lines old aneurismal sacs, nor of the loose and soft texture that belongs to recently clotted blood.

The coats of the popliteal artery, and a continuation of them, such as aneurisms ordinarily exhibit, formed the back part of the sac; while the front and sides were made up of the thigh-bone, the back of the knee-joint, and the neighbouring muscles. The fleshy and tendinous fibres of the vasti were exposed on clearing out the coagulum, which not only covered the back part of the femur, but had also advanced on each side towards the front, so as nearly to have insulated the bone. The periosteum was removed at several points (the popliteal vein was obliterated).

When the patient was more closely questioned, after this examination of the limb, he stated that the swelling had continued of moderate size until five weeks previous to admission into the hospital, when it suddenly enlarged, and that it had increased considerably from that time. The pulsation, which the tumour no doubt had possessed at an early period, had altogether escaped his notice.

Remarks by Mr. Lawrence.—I conclude that the case had been originally a popliteal aneurism of the usual kind; that the sac had given way in front, so as to convert it from a circumscribed into a diffused aneurism, and thus to present to us the deceptive appearance of an immense sarcomatous tumour. Since this case has happened, I have heard of two or three other somewhat similar cases.

The very large quantity of the coagulum, and the state of the thigh-bone, may create a doubt whether tying the femoral

¹ 'Med.-Chir. Trans.,' vol. viii, p. 497.

artery would have been a successful method of treating this case. However, had I suspected the nature of the affection, I should certainly have made the trial; and should have undertaken it with a confident expectation of success, grounded on experience of the efficacy and extent of those natural processes by which such effusions are absorbed, and such cavities obliterated. I have stated this case to put others on their guard, and shall be happy if what I have said should in any instance prevent so serious a mutilation as that which my patient suffered.

CASE 57.—*Ruptured aneurism; difficult diagnosis; exploration; amputation; death.*¹

Insane Portuguese, æt. 40, admitted into London Hospital, under Mr. Luke, with supposed popliteal aneurism of an urgent nature. There was a large tumour, circumscribed at its upper part, extending from the middle of the inside of the right thigh to the inner part of the knee-joint. The skin covering the swelling was discoloured, and there was a deceptive feeling of fluctuation; but no pulsation was perceived, either by the touch or by means of the stethoscope. Compression with the hands did not in the least reduce the volume of the swelling. The whole limb below the disease was extensively œdematous; consequently the anterior and posterior tibials could not be felt. No information of the history of the case could be elicited from the man, or from those who first brought him to the hospital, except that the swelling first commenced about two months back. Mr. Luke explored the tumour with a grooved needle, and a small quantity of dark-coloured blood escaped. On the following day a consultation was held, and after further exploration, amputation was performed. Did well for first week; sloughs formed on back, and health began to give way. Death in one month.

Examination of limb.—Tumour consists of a large cyst, formed by muscles and surrounding soft structures, condensed, containing a large mass of dark coagulated blood under muscles and in cellular tissue of popliteal region, at bottom of which and low in space, opening in artery as large as calibre of vessel itself, surrounded by remains of a sac with an irregular margin.

CASE 58.—*Ruptured aneurism; rapid gangrene; amputation; recovery.*²

A healthy sailor, æt. 30, admitted into the Bristol Infirmary. Had experienced a little pain in his right ham for some days, when he noticed there a pulsating tumour, the size of a walnut. On the fourth day from this, he felt something burst in it, during an ordinary fit of sneezing, and his leg immediately swelled and became painful. The swelling and pain increased, and in two or three days gangrene commenced in the instep and foot, and quickly spread upwards, accompanied with

¹ 'Med. Gaz.,' vol. vii, p. 446.

² 'Medico-Chir. Review,' vol. xi, p. 513.

severe constitutional irritation. Amputation was performed on the seventh day from the bursting of the aneurism; the case did well.

On examining the limb, an aneurismal sac was discovered, capable of containing four or five ounces of blood, originating from the middle of the popliteal artery posteriorly, about one inch of which opened into it. It was imperfectly formed behind, and presented there two openings, each readily admitting a couple of fingers; through these the contents had escaped. An abundance of blood was extravasated between the muscles and beneath the integuments in all directions. The sac elsewhere was firm and strong, and lined with thick and dense laminæ of fibrine. The popliteal vein was filled by a firm coagulum for the space of two inches, quite obstructing it.

CASE 59.—*Ruptured aneurism; no tumour or pulsation, but general enlargement of limb; difficult diagnosis; exploration; amputation.*¹

A cattle-drover, æt. 32, admitted into the Bristol Infirmary with the left lower extremity twice the size of the other, the swelling reaching to the lower third of thigh; the foot and surface of the leg cedematous, with distinct fluctuation as of matter underneath; considerable pain, but not much tenderness in different parts of the leg; general health greatly impaired; restless nights; hectic and other symptoms of constitutional irritation. He had been for many years in the habit of walking great distances, and had travelled upwards of 100 miles in two days, very shortly before he was taken ill. The disease commenced two months before admission with considerable pain in the calf of the leg, which shortly confined him to bed, and was followed by cedematous swelling about the ankle. The pain and the swelling increased, and his health became disturbed with their advance.

He was not sensible of any sudden bursting, neither at any time was he conscious of the existence of a distinct tumour or pulsation. It was determined to explore the most fluctuating part, and an opening accordingly was made about the middle of the calf, but nothing escaped. By introducing the finger, an abundance of soft coagulum could be felt, occupying a large cavity within. Amputation was now immediately performed. The man afterwards was in a fair way to recovery.

On examining the limb, an aneurismal sac, large enough to hold twelve or fourteen ounces of blood, arose from the posterior part of the middle of the popliteal artery, about two inches of which communicated with it. Anteriorly and laterally it was distinct and strong, but very defective posteriorly, where numerous breaches existed, through which its contents could find a ready issue. The sac, such as it was, contained a quantity of old coagulum, but not much laminated fibrine. The popliteal vein was pervious throughout. An immense quantity of extravasated blood was found in various parts of the leg, particularly between the muscles; and here and there a little circumscribed purulent effusion.

CASE 60.—*Ruptured aneurism; difficult diagnosis; exploration by lancet; slight secondary hæmorrhage; amputation; exhaustion; death.*²

John Morgan, æt. 32, seaman, admitted on board the "Grampus" Hospital-

¹ 'Medico-Chir. Review,' vol. xi, p. 513.

² Ibid., vol. xiv, p. 438.

ship, on Sept. 28th, 1830; his appearance emaciated and exsanguine; his countenance sallow and anxious. He complained of pain in the situation of a tumour, about fourteen inches in circumference, occupying the lower third and inner side of the *right* thigh, presenting its greatest bulk in that situation, and gradually decreasing forwards to the ham and the outer side of the thigh. The circumference of the tumour had a defined, bordered margin; the summit was tense, elastic, and gave to the touch an evident sense of fluctuation; the integuments retained their natural colour; the leg was somewhat œdematous, and remained flexed, without the power of extension. The patient denied that any morbid appearance or uneasiness had existed in the part previous to seven weeks since, when, without any assignable cause, the whole leg and foot became swelled and tense, and ultimately settled into the present tumour. Upon the most careful examination no pulsation could be detected in the enlarged surface, except to a slight degree in that position which lay immediately over the popliteal artery. Pressure upon the femoral artery produced no diminution in the bulk of the tumour, nor could any sound be detected upon application of the stethoscope. The patient had no recollection of any pulsating tumour having ever appeared in the ham.

He had had some severe rigors, and evidently suffered much constitutionally. Under these doubtful circumstances, the limb was placed on a pillow, resting on its outer side, and evaporating lotions applied.

On the following day, the tumour being in no way diminished, but rather more tense, it was determined to explore; a lancet was introduced into its substance, to the depth of an inch, and in a valvular direction, but with no other result than the escape of a few drops of dark blood. The wound was closed by adhesive plaister, and the limb left alone.

On the next day, at noon, the patient having moved the limb roughly, and placed it over the side of his bed, about an ounce of fluid blood, unattended by arterial jet, passed from the aperture made in the tumour the day previous, and was easily checked by slight pressure with lint.

The two following days were passed without any change in the appearance of the tumour, with the exception of a slight apparent extension towards the upper part of the thigh. A probe, introduced into the lancet-orifice in the tumour, passed its entire length in every direction without resistance, and without hæmorrhage.

On the sixth day, the swelling had extended considerably up the thigh, occupying its lower half, was much more tense at its original seat, and gave a more evident sense of fluctuation immediately above the patella. Amputation of the thigh was now had recourse to. After some vicissitudes of rallying and exhaustion, he sank the next day at 11 p.m.

Upon examining the limb, between two and three pints of dark blood, partly coagulated and partly fluid, were found occupying the lower half of the thigh, nearly insulating the lower third of the shaft of the femur, which to the extent of four inches was denuded of periosteum, and presented a honeycombed appearance. The chief volume of effused blood occupied the situation of the muscles, and in many parts was in contact with the integument, chiefly so immediately above the patella. A fine aneurismal sac, about the size of a pullet's egg, was found on the anterior surface of the popliteal artery; the sac, at its upper third and anterior surface, was rent to the extent of two inches in a transverse direction. Immediately above the torn sac, and externally, appearing to form a portion of it, was a second dilatation of the artery, forming a sac the size of a small walnut, lined with a thick

layer of coagulum, and communicating with the larger and torn sac by an opening in size not exceeding the third of the natural calibre of the femoral artery. The cellular tissue of the leg and foot was loaded with serum.

CASE 61.—*Ruptured aneurism ; amputation at first refused, and consented to seven days after ; secondary hæmorrhage ; death.*¹

E. K—, æt. 34, of delicate appearance, under the care of Mr. Tegart, of Dublin. He had been a rough rider in a Lancer regiment, and latterly in the police-force. He presented himself with a popliteal aneurism in the left limb. Had symptoms of organic disease of heart and whole arterial system. On the eleventh day after admission, the patient felt something burst in his ham, after which he suffered great pain. The aneurism had become diffused, and nothing now remained but amputation, to which he refused to submit.

He continued to suffer much pain for a few days, and on the seventh day after the first attack he was found in great agony, a second rush of blood having taken place.

The calf and entire back of the leg was enlarged, tense, and swollen almost to bursting ; it was hard and shining, presenting, in many parts, a dark and mottled appearance ; the heat of the limb was diminished, and no pulsation could be felt in the anterior tibial artery ; pulse jerking and rapid ; great action of heart, and much anxiety of countenance. He now implored to have the limb amputated, which was performed. Secondary hæmorrhage occurred, and was uncontrollable. He died in forty-eight hours.

Examination of limb.—Extensive extravasation of blood down to tendo Achillis ; large masses of coagula under gastrocnemius ; slit in sac, one inch long, by which artery communicated in sac ; small round aperture at bottom of sac, where it bursted.

See drawing B. c. 220, Houston ; ‘ Catalogue of Museum, Royal College of Surgeons, Ireland,’ vol. ii, p. 123 ; showing an extensive extravasation of blood among the muscles of the leg, the result of bursting of a small aneurism of the popliteal artery.

CASE 62.—*Ruptured aneurism ; difficult diagnosis ; exploration ; amputation ; recovery.*²

S. L—, æt. 37, agricultural labourer, admitted under Mr. Mackmurdo into St. Thomas’s Hospital. Has been generally healthy. About twelve months since he received a blow on fore part of knee, causing pain, but this gradually subsided ; and, on one occasion whilst walking, he suddenly felt something give way in the ham, and his knee became at once stiff and painful. Eight months after this he observed a swelling, about size of orange, in ham ; no pulsation at first, but afterwards very evident ; tumour increased rapidly, and pulsation ceased. A lancet had been introduced, and a small teacupful of blood escaped ; wound closed.

On admission, there was enormous swelling of ham and inner part of knee,

¹ Porter on ‘ Aneurism,’ p. 88.

² ‘ Lancet,’ Sept., 1846.

slightly elastic; integuments a little discoloured; surface smooth; foot and ankle œdematous; no bruit to be heard; femoral artery apparently healthy.

Exploration made, and dark-coloured blood escaped; diagnosis doubtful as to its being fungus hæmatodes or aneurism.

On following day a sudden increase took place in swelling, integuments having a bluish appearance, very thin and tense, and very hot; oozing from punctures; circumference of limb above knee, two feet; no pulsation or sound; pain of most acute character. Suffered so much, requested to have limb amputated; performed one week after admission. Recovered health slowly; aneurisms in other parts of body.

On examining leg, swelling chiefly composed of imperfect, irregularly-formed coagulum; femoral artery from above could be traced into an aneurismal sac of size of pigeon's egg, and seated close to the perforation of triceps; artery nearly imperious. The sac at anterior and lower part imperfect, but aperture did not appear to be of recent origin. Distal end of artery three inches below sac.

CASE 63.—*Aneurism punctured by lancet; extravasation rapid; sudden hæmorrhage through wound on third day; amputation; secondary hæmorrhage; recovery.*¹

James O'Brien, æt. 36, a delicate leucophlegmatic-looking man, of independent circumstances. Has been of intemperate habits, but for last six years been a strict teetotaller. Admitted into Limerick Infirmary, under Dr. Wilkinson, with a popliteal aneurism (right), of size and form of goose-egg, of six months' duration, and entirely filling up the space. It was more prominent on its upper and outer side, where an opening had been made with a lancet, three days previously, by a country practitioner; which operation, he says, was followed by slight bleeding, a bandage being applied. He was advised to come into the infirmary.

The surface of the tumour is of a purplish-reddish colour, without any pulsation; and on examination with the stethoscope, we could not detect any *soufflet*; under moderate pressure it is quite compressible, but on its removal it rapidly resumes its original form and bulk. Complains of some pain in the ham and leg, which is slightly swollen; the foot is œdematous, and of a mottled-white colour; the entire limb is flexed on the pelvis, the femoral artery acting most violently; pulse, 100 in a minute.

While consulting about his case in an adjoining ward, we were hastily summoned by the nurse, who said he was bleeding to death. On reaching his bedside we found him quite faint, with a large jet of blood coming *per saltum*, in a full stream, through the external wound. It was restrained by pressure with the finger on the external opening, and a tourniquet was applied. We conceived that amputation of the limb was the only safe course to adopt, but which view was opposed by a medical gentleman present, who advocated the tying of the femoral artery in Scarpa's space, which we dissented from on two grounds. In the first place, we contended that the femoral artery was in all likelihood so diseased, that the obliteration of its canal could not take place, and secondary hæmorrhage would follow, either at the part where the ligature was applied, or where the sac had been opened; it being in fact now circumstanced like to a wounded vessel, in which a ligature is of little use, unless applied at the bleeding points; and that, were we to follow his advice of tying it at a distance, the collateral circulation would in a short time be restored, and hæmorrhage from the sac through the opening would be the result. Our second reason

¹ 'Dublin Journal,' New Series, vol. iii, p. 549.

was, the dread of mortification ensuing before the collateral circulation had sufficient time to become fully established; but this was looked upon as minor in point of magnitude to the former, from the length of time which the aneurism took to form, consequently allowing the collateral circulation to be more or less established.

The limb was removed by amputation, and only had three vessels to secure. Secondary hæmorrhage on the following day; stump laid open; cold and compression applied, but with no success. Two moderately-sized vessels secured. Made a slow recovery.

On examining the limb, and on cutting into the sac, we found it filled with fibrine, deposited in laminæ, and as firm as muscular fibre. The opening which communicated with the sac was situated in the articular surface of the popliteal artery, but a little towards its outward margin.

CASE 64.—*Aneurism cured by compression, twenty-five days after rupture; bursting through skin; gangrene; arrested below knee; amputation; death.*¹

Michael B—, æt. 36. Strong, healthy Irishman; a plasterer's labourer. Admitted into Liverpool Royal Infirmary, under Mr. Stubbs, with popliteal aneurism of three weeks' standing; of size of orange. Compression employed, and successful at end of twenty-seven days. Left the hospital, and continued quite well. About twenty-five days after this, while in bed, he found his knee had become suddenly enlarged and painful, which continued in this state for six days, when hæmorrhage to a considerable extent took place from the ham. He was re-admitted into the hospital on the third day. Face and body generally emaciated; aspect ghastly; pulse rapid; voice feeble. Much enlargement of knee; integuments firm and stretched, and livid; foot and lower part of leg cold and gangrenous; thigh œdematous. By administration of stimulants he rallied, and in the course of a few days he improved, and gangrene arrested a few inches below knee.

Amputation was performed on fifteenth day; did not rally, and died six days after operation.

Examination of limb.—Parts in ham disorganized; unable to discover whether coats of original aneurism had given way, or whether the rupture had taken place elsewhere.

CASE 65.—*Aneurism; compression of femoral for one week, with arrest of pulsation; sudden rupture; rapid gangrene; amputation; secondary hæmorrhage; death.*²

London Hospital, under Mr. Luke, a man, æt. 38, under care on account of a popliteal aneurism, from which he had suffered for eight months. The tumour was of considerable size, but did not quite fill the whole space. It extended upwards and outwards. He was in good health, and seemed a favorable subject for compression treatment.

Pressure was commenced and kept up without material inconvenience for a month, at the end of which time pulsation had all but ceased. At this juncture the tumour suddenly increased in size; the leg became œdematous, and shortly afterwards lividity of the foot was apparent. Mortification of the foot setting in, it was decided to amputate.

¹ 'Med. Times,' vol. xxxi, p. 89.

² 'Med. Times and Gazette,' January, 1856.

The operation was performed (through the thigh) on the third day from the commencement of the gangrene. Death, from secondary hæmorrhage, followed about two weeks after operation.

Examination of limb, after removal, showed that the sac had given way at one point where it was very thin; the tumour was filled by laminated coagula, and the channel of the artery through it was very small.

CASE 66.—*Aneurismal dilatation of posterior tibial vein; rupture thereof; slow extravasation; exploration; hæmorrhage; amputation; recovery.*¹

George M—, æt. 28, a tide-waiter, admitted into Guy's Hospital under Mr. Cock. About eleven years ago he received a stab with a knife in the popliteal space; and two weeks after, in consequence of secondary hæmorrhage, the femoral artery was tied. The ligature came away on twelfth day, and patient recovered. He regained the full use of his leg, and never experienced the slightest inconvenience; neither has he ever been aware of the existence at any time of any tumour or swelling. He, however, was the subject of varicose veins two years after the operation. After recovering from an attack of fever, and about five weeks ago, when endeavouring for the first time to walk about, he discovered that his leg was stiff, painful, and swollen, which gradually increased.

On admission, there was general enlargement and œdema from the knee down to the toes. The cellular effusion was greatest about the instep and ankle. The principal enlargement was at the back of the leg, where the calf was bulged out into a prominence extending from the knee to rather more than half-way down, tense and tender. Deep-seated fluctuation was very distinct, and it was evident that a large collection of fluid existed under the gastrocnemius muscle. He had been the subject, during the last few weeks, of occasional rigors, with exacerbations of pain and fever; and there was every reason to suppose that a large collection of pus had formed between the superficial and deep-seated muscles.

The femoral artery could be felt pulsating along the upper part of the thigh. The anterior and posterior tibial arteries could be felt to beat vigorously, after displacing the subjacent œdema by pressure; not the slightest sense of pulsation, not the faintest sound or murmur, could be detected in the tumour of the calf; it was totally uninfluenced by arresting the flow of blood through the artery at the groin.

An incision was made into the cavity near the upper and inner part of the leg; a flow of blood followed the withdrawal of the lancet, until between two and three ounces had been spontaneously discharged; the blood was dark, grumous, and pitchy in its character, did not coagulate, and had evidently been extravasated for a considerable period. Its evacuation sensibly diminished the tension of the swelling, and the pain was relieved.

On the following day, a copious discharge of pus took place, and in a few minutes nearly a pint had flowed away. This was followed by a marked improvement in the symptoms, both locally and generally, for the next ten days. The pus continued to be discharged, and the patient had begun to rally in health and strength. The leg returned to its natural size and shape.

Fifteen days after the puncture had been made, when the state of the patient

¹ 'Med.-Chir. Trans.,' vol. xxxiv, p. 328. This case hardly belongs to the series, but it bears upon the subject of ruptured aneurisms in the popliteal space.

promised a speedy convalescence, arterial hæmorrhage suddenly took place from the wound; and before competent assistance could be afforded, he had lost nearly three pints of blood. The entire cavity of the original abscess was tense, and distended to more than its original size, whilst its walls had evidently given way, and blood was gradually effusing itself upwards through the popliteal space into the thigh. The entire leg had a swollen, shiny, and livid appearance.

Amputation, a short distance above the knee, was immediately performed. Recovery.

On examining the limb, the gastrocnemius was expanded and very thin, as also the soleus, which was exceedingly stretched and distended; beneath these was a large diffused collection of blood, extending half-way down the leg; a large aneurismal sac, formed by a dilatation of the posterior tibial vein, was discovered, and this had given way by an ulcerated opening at the upper part, near the entrance of the vessel.

Remarks by Mr. Cock.—"Three methods of treatment suggested themselves. The first was to place a ligature on the upper part of the femoral or external iliac artery; the second was to lay open the cavity of the leg, evacuate its contents, search for the vessel which afforded the hæmorrhage, and if possible, secure it; the third was to amputate above the knee. We came to the conclusion that a ligature on the upper femoral or iliac artery would probably throw us on to the horns of a dilemma; that, from the free collateral circulation resulting from the former operation, it might at best afford but a temporary check to the bleeding; whilst, on the other hand, if the supply of blood to the leg became materially diminished in its then present state, gangrene would follow as a most inevitable result. This proposition was, therefore, abandoned. The second shared the same fate, as we considered that the operation of laying open the cavity and searching for the vessel was, as regarded the collapsed state of the patient, too severe in its character, and, considering our ignorance of the source of hæmorrhage, too uncertain in its results to be attempted. Our last resource was amputation, and the leg was removed a short distance above the knee."

CASE 67.—*Ruptured aneurism of the popliteal artery; gangrene; amputation; secondary hæmorrhage; ligature of femoral; recurrent hæmorrhage; re-amputation; death.*¹

A coal-porter, æt. 50, admitted into King's College Hospital, under Mr. Fergusson.

¹ 'Pathological Transactions,' vol. ix, p. 122.

While carrying a sack of coals up the ladder of a waggon, his right foot slipped and he fell, twisting his knee upon the lower rail. When seen, eight hours after the injury, the knee and ham were very intensely swollen, and discoloured by ecchymosis, and very painful to the touch. He complained of much pain in the limb, and a feeling of numbness extending down to the toes. Pulsation was not very apparent in the swelling at this time; but on questioning the patient a day or two afterwards, he stated, that twenty years ago he experienced a similar injury to the same knee, and that ever since it had been weaker than the other; and he thought that a swelling had remained behind the knee up to the present time, but had not grown larger, nor caused him much annoyance of late. About this, however, he was not very clear or decided.

It gradually became evident, by the increase of the swelling, the more decided pulsations throughout the tumour, especially towards the inner side, and by the absence of pulsation in the tibial arteries, that the popliteal artery had given way, either from the previous existence of an aneurism, or from ossification of its coats. The numbness of the toes and pain in the leg increased, gangrenous discoloration followed, and upon the toes and heel patches of vesication and the more decided evidences of sphacelus were apparent. These gradually extended over the whole foot. On the fourth day, sensation was lost up to the middle of the leg; and at the site of the injury, and over the calf, several dark-coloured vesications had formed, and assumed a decidedly sphacelated appearance. The leg, at and below the knee, was much swollen and œdematous. No line of demarcation becoming apparent, and the patient's health beginning to give way, it was deemed advisable to perform amputation above the injured point. He was attacked with violent delirium five days after the operation, which was combated by stimulants and support. On the twenty-first day secondary hæmorrhage ensued, which could only be arrested by ligature on the superficial femoral artery. Seven days after, bleeding recurred, and re-amputation was performed higher up; but he died exhausted ninety-six days after first amputation.

On *examination of limb*, as detailed in 'Pathological Transactions,' the specimen shows an aneurism of the popliteal artery at the point of departure of the several branches. It is of an elongated shape, and of the size of a large pear, inclining to the inner side of the popliteal space, with the internal popliteal nerve stretched across it. The walls are remarkably thin, especially at the lower end of the tumour, under the bifurcation of the gastrocnemius muscle. At this point the walls of the sac had given away, by the formation of a ragged, irregular opening about an inch long. A few delicate layers of fibrine lined the interior of the sac at its upper part; the rest was filled by a loose coagulum. The effused blood had made its way down the leg between the gastrocnemius and soleus muscles, and had thence escaped into the subcutaneous textures on the back of the leg, giving rise to much gangrenous ecchymosis, which was very apparent on the surface, and raised the cuticle into large vesications. Under the tendon of the semi-membranosus muscle, the blood had passed into the bursa which is found there, and evidently communicated with the synovial cavity of the knee-joint at the inner condyle.

CASE 68.—*Double aneurism; left treated by compression for nearly six months, when ligature of femoral artery is*

process of cure ; right aneurism treated by ligature of femoral ; sac gave way at end of second week ; gangrene ; death.¹

Arthur J—, æt. 36, strong, healthy, admitted into King's College Hospital under Mr. Bowman with double popliteal aneurism.

Left large in size, soft and fluid ; of two months' duration ; no cause. Pressure on femoral, badly borne, but steadily persevered with ; it was commenced in November, continued through December, January, February, and March, when diminution in size, and more solid feel. In April kneading of aneurism ; but a few days after this, ligature of femoral. Wound healed. Still feeble pulsation in aneurism.

May 5th, patient drew up left leg so as to bend knee ; immediately jet of blood through small opening. Re-application of ligature on femoral at site of former operation, free suppuration followed.

Right only noticed on admission. Right femoral tied on May 2d ; on 10th, extreme tenderness on pressure in ham and over leg. An intensely painful swelling appeared towards lower end of tibia. The superficial veins over calf purplish and very distinct. On May 16th, suddenly awoke in great trepidation and anxiety, and on following day seized with acute pain in calf and ham. The leg and feet slightly œdematous ; integuments dusky. On 21st gangrene set in. Death on following day.

Examination of left : Opening in sac one and three quarters inch oblong ; blocked up by fibrine. Femoral well plugged at site of operation.

Examination of right : Femoral well plugged at site of operation. Aneurismal sac had burst—surrounding parts in a very gangrenous state.

CASE 69.—*Aneurism undergoing compression of femoral ; sudden giving way of sac ; ligature of femoral ; recovery.²*

J. W—, æt. 37, a stonecutter, of spare make, but well proportioned, habitually healthy.

On 17th March, 1848, he was admitted into the hospital under Mr. J. W. Wright, surgeon-major, Grenadier Guards, for popliteal aneurism (left), of the form and size of an orange ; he was only aware of the swelling five days previously, and had only then had pain and swelling in the knee.

Four days after admission, compression of femoral resorted to. Favourable progression until eighth day of compression, when patient suddenly seized with acute pain in knee, followed by a quick tumefaction of parts. On examination the popliteal tumour appeared unchanged, but an additional tumour was found on the inner side of the joint, circumscribed, flattened, and pulsating in a slight degree ; it was about the size of twice that of the palm of the hand, with considerable prominence.

The femoral artery was tied, under chloroform. Ligature separated on twenty-sixth day. Recovery.

¹ 'British Med. Journal,' 1857.

² 'Med.-Chir. Trans.,' vol. xxxii, p. 167.

Summary of Cases of

No.	Name.	Age.	Occupation, habits, &c.	Duration of aneurism previous to rupture.	Cause of rupture.	Interval between rupture and operation.
28	Richard D—	32	Blacksmith	Five months	Slipped and fell on ground, and bruised ham	—
29	Ann F—	40	—	Five months	Whilst hobbling into room, fell forwards	Experiment
30	Harriet L—	23	Dressmaker good health	Four months	Spontaneous? unknown	—
31	Peter B—	22	Formerly soldier	Two years	Not stated; spontaneous?	Three weeks
32	J. B—	38	Blacksmith; intemperate, pale, sallow	Six months	—	—
33	Man	25	Temperate; formerly in army in Crimea	Eleven weeks, aneurism in process of cure by compression	Rupture of artery above sac	—
34	Thomas B—	32	Soldier; muscular, intemperate	Twelve months	—	Eight days
35	—	46	Navigator; well nourished, fine man	Six weeks	None	—
36	John H—	30	—	Six weeks ? Two years	None	One day
37	James B—	38	Formerly soldier; strong, healthy	Fifteen years	Leg bruised between two cows, and much subsequent exertion.	Two to three months
38	Chinese	56	Cake-maker	Two months	—	—
39	Jeremiah T—	35	Labourer in coal trade	Five weeks	None; gradual	Several days

Ruptured Popliteal Aneurism.

Operation, &c., performed.	Effects, and secondary operation.	Result.	Surgeon.	Hospital, &c.
Operation refused	Bursting of tumour externally; hæmorrhage	Recovery	Reported by W. Wilson	Westminster Hospital.
Exploration on sixth day; operation refused	Suppuration; sudden profuse hæmorrhage	Death twenty-four days after admission	Dr. Hobart	Cork Infirmary
Intermittent compression for 134 hours during twenty days	Tumour became solid, and she left hospital on eleventh week; on second day again ruptured and recovery by pressure	Recovery	Hargrave	City of Dublin Hospital.
Compression carefully employed	—	Recovery	Dr. Jacob	Queen's County Infirmary.
Compression	Curative attempts; attacks of erysipelas; tumour burst, but no hæmorrhage; exhaustion	Death	Hutton	Newcastle.
Aneurism undergoing compression; indefinite symptoms	Sudden hæmorrhage from bursting through skin	Death; artery ruptured above sac	Dr. Murray	Belfast Infirmary.
Compression for six days, ineffectual ligature of femoral	Ligature did not come away for five months	Recovery protracted	Dr. Mitchell	Plymouth Military Hospital.
Forcible flexure of knee for thirteen days, failure; ligature of femoral	Ligature came away on twenty-first day	Recovery	Moore	Middlesex Hospital
Femoral tied	Gangrene rapid	Death on twelfth day	Key	Guy's Hospital.
Ligature of femoral, also popliteal aneurism in the other, and tied and did well.	—	Recovery	Collis	Meath Hospital.
Operation proposed and refused; bursting thereof externally on third day; ligature of femoral	Gangrene on fourth day; great exhaustion	Death on fifth day	Hobson	Canton Hospital.
Ligature of femoral	Ligature came away on seventeenth day	Recovery	Quain	University College Hospital.

Rupture of the Pigeon's Artery

No.	Name	Age	Profession, habits, &c.	Duration of mor- bidity or time in course of rupture	Interval between rupture and operation
40	Male	35	—	Seven weeks : Some relief for four weeks	Immediate
41	T. W—, male	34	Strong, healthy	Eleven weeks	—
42	Male	25	Farm labourer	Three months	Least wound One day
43	Male	—	—	—	—
44	James F—	30	Sailor; good heart	Eight weeks	—
45	G. B—	30	Stonemason	Three months	—
46	Mr. Lucas	43	Organ-builder; gouty	Five years	Gradual, suc-cessive
47	William L—	36	Tailor	One year	Compression for four days; sac burst externally, five days after leaving off pressure
48	John F—	50	Seaman; man of colour	Four months	Unknown
49	William B—	—	—	Eleven months	Engaged in hoeing turnips
50	Soldier	25	Irritable; anxious	Two weeks; cured in forty-eight hours by compression	Sudden
51	Coal porter	28	Very intem- perate	Probably two years	Blow on sac
52	James W—	36	Joiner; weak and phthisical	Eleven months	—
53	Labourer	65	Intemperate	Three months	—

Operation, &c., performed.	Effects and secondary operation.	Result.	Surgeon.	Hospital.
Ligature of femoral	—	Recovery	Birkett	Guy's Hospital.
Compression in- effectual; ligature of femoral	Gangrene; amputa- tion	Recovery	Norgate	Norwich Hospital.
Ligature of femoral	Gangrene; amputa- tion twelve days after ligature	Death	Callaway	Guy's Hospital.
Ligature of femoral after exploration of tumour by lancet	Hæmorrhage from wound; amputa- tion	Recovery	Chirurgus	Plymouth.
Ligature of femoral	Erysipelas, bursting of sac, and suppu- ration; amputa- tion one month after	Death	Allan	Royal Infirmary, Edinburgh.
Exploration by in- cision; ligature of femoral	Hæmorrhage; am- putation	Recovery	Sir A. Carlisle	Westminster Hos- pital.
Ligature of femoral	Gangrene fifth day; amputation	Recovery	Sam. Cooper	University College Hospital.
Ligature of femoral	Gangrene sixth day after; amputation seventh day	Recovery	Jolley	—
Compression could not be borne; am- putation	—	Recovery	Adams	Richmond Hospital, Dublin.
Compression at- tempted, could not be carried out; amputation	—	Recovery	Bulley	Royal Berkshire Hospital.
Amputation	—	Recovery	Dr. Clayton	Military Infirmary, Dublin.
Compression favor- able for sixteen days; suddenly left hospital; gangrene feared	Re-admitted in two days, and amputa- tion on sixth day	Not stated	Smily	Meath Hospital.
Compression inef- fectual; ligature of femoral re- fused	Gangrene; ampu- tation	Recovery	Leather	Liverpool Work- house.
Compression inef- fectual for five days continuously	Amputation	Death in twen- ty-nine days; pyæmia	Collis	Meath Hospital.

No.	Name.	Age.	Occupation, habits, &c.	Duration of aneurism previous to rupture.	Cause of rupture.	Interval between rupture and operation.
54	Louis P—	32	Cultivator; accustomed to drink	Six weeks	—	—
55	William S—	32	Corporal; tall, muscular	Fifteen months; diffused in right, circumscribed in left	—	—
56	Man	Middle aged	—	Five months	Not known	Five weeks
57	Portuguese	40	Insane	Two months probably	do.	—
58	Sailor	30	Healthy	Noticed only a few days	Fit of sneezing	Seventh day
59	Cattle drover	32	Impaired health; irritability	Two months	Gradual; successive	—
60	John M—	32	Seaman; sal-low, emaciated	Norecollection	No cause	Eight weeks
61	E. K—	34	Cavalry soldier	Unknown	—	Twelve days
62	S. Z—	37	Agricultural labourer	Twelve months	Introduction of lancet	One day
63	James O'B—	36	Delicate	Six months	Opening by lancet	Three days
64	Michael B—	36	Strong, healthy; labourer	Three weeks; compression twenty-seven days; cure, twenty-five days after his rupture	—	Fifteen days
65	Man	38	In good health	Eight months	Unknown	Three days
66	George M—	28	Tide-waiter	Wound of popliteal artery; ligature of femoral; recovery; eleven years	Gradual; successive	Seven weeks
67	Man	50	Coal porter	Uncertain; ? twenty years	Fell, twisting knee on rail of ladder	Eight days

Operation, &c., performed.	Effects and secondary operation.	Result.	Surgeon.	Hospital.
Compression seven-teen days, and digital compression for ninety-four hours after	Amputation	Death on sixth day; pyæmia	Nelaton, quoted by Broca	Clinical Hospital, Paris.
Left, amputation; right, ligature of femoral three months after former	—	Recovery	Harris	Whitehaven Hospital.
Incision and immediate amputation	—	Recovery probable	Lawrence	St. Bartholomew's Hospital.
Exploration; amputation	—	Death in four weeks	Luke	London Hospital.
Amputation	—	Recovery	—	Bristol Infirmary.
Exploration by incision; amputation	—	Recovery	—	do.
Amputation	—	Death	Bennett	Hospital Ship "Grampus."
At first refused any operation; amputation	—	Death	Tegart	Dublin.
Exploration by incision; amputation one week after	—	Recovery	M'Murdo	St. Thomas's Hospital.
Amputation	—	Recovery	Wilkinson	Limerick.
—	Gangrene; amputation	Death on sixth day	Stubbs	Liverpool Infirmary.
—	Gangrene; amputation	Death in two weeks	Luke	London Hospital.
Amputation	—	Recovery	Cock	Guy's Hospital.
Gangrene; amputation	Violent delirium; secondary hæmorrhage on twenty-first day; ligature of femoral; recurrent hæmorrhage; reamputation	Death, ninety-six days after first amputation	Fergusson	King's College.

No.	Name.	Age.	Occupation, habits, &c.	Duration of aneurism previous to rupture.	Cause of rupture.	Interval between rupture and operation.
68	Arthur G—	36	Strong, healthy	Double aneurism. <i>Left</i> —two months pressure ineffectual; ligature of femoral; secondary hæmorrhage; re-application of ligature; cure. <i>Right</i> —not known; ligature of femoral	—	Eighth day
69	J. M —	37	Shoemaker; spare habit, healthy	Only noticed six days; compression for eight days; ineffectual	Sudden	—

We have already too far encroached upon the limits of the present reports, and we must reluctantly bring to an abrupt close a communication which we would have wished to have extended to a more definite and final conclusion.

But the material brought forward may, we trust, be of sufficient weight to lead to further investigation, and to enable others to prosecute the inquiry, so as to lead to a more correct or accurate means of determining the proper and appropriate method of treatment to be adopted in similar cases. We shall, however, conclude by offering a general summary of the treatment and results of ruptured popliteal artery and aneurismal sac in the 70 cases alluded to in this report.

The most important point for inquiry is, as to whether in these cases we should attempt to save the limb; now, in 16 cases out of 70, viz., 22·82 per cent., recovery with a sound limb took place; hence there are fair grounds and reasons for this line of treatment when thought justifiable, but much discretion must be employed; the amount and rapidity of the extravasation must be taken into consideration, and its influence on the circulation in the limb below, as shown by loss of temperature, loss of sensation, the presence of œdema, and the absence of all pulsation; the age, habits, and constitution of the patient, must also necessarily engross our attention.

Operation, &c., performed.	Effects and secondary operation.	Result.	Surgeon.	Hospital.
—	Gangrene	Death	Bowman	King's College.
Ligature of femoral	Ligature separated on twenty-sixth day	Recovery	Wright	—

In 32 cases where amputation was not performed, 16 recovered; 16 died. In 38 cases in which amputation was performed, 21 recovered; 15 died; and in 2 the result not stated. Thus, of 69 cases there were 37 total recoveries, 54·41 per cent; and 31 total deaths, 45·58 per cent.

The following subdivisions fully expose the treatment and results :

Cases in which no operation was performed : 6 cases; 2 recovery, and 4 deaths.

- Case 6. Complete rupture; gangrene; spontaneous amputation below knee. Recovery.
- „ 9. Complete rupture; sudden hæmorrhage on sixteenth day. Death.
- „ 21A. Partial rupture; secondary hæmorrhage. Death.
- „ 24. Partial rupture; secondary hæmorrhage and gangrene. Death.
- „ 28. Ruptured aneurismal sac; bursting of tumour externally; hæmorrhage. Recovery.
- „ 29. Ruptured aneurismal sac; exploration; suppuration; sudden profuse hæmorrhage. Death.

Cases in which compression was employed : for more elaborate details see page 353.

- Case 30. Compression intermittent for 134 hours, during twenty days. Recovery.
- „ 31. Compression carefully employed for nineteen days. Recovery.
- „ 32. Compression for two months; erysipelas; extravasation, &c. Death.

Case 33. Compression being used with success; when artery gave way above sac, &c. Death.

Cases in which popliteal space was laid open by incision, and ligature placed above and below rupture.

Case 2. Complete rupture; immediate operation; gangrene; amputation. Death.

„ 16. Partial rupture; operation performed on eighth day; gangrene thirty-six hours after. Death in six days.

„ 17. Partial rupture; operation performed in sixth week; ligatures came away on nineteenth day. Recovery.

„ 18. Partial rupture; operation performed at several days; suppuration. Recovery.

„ 19. Partial rupture; operation attempted nine months after, and failed; amputation. Recovery.

„ 20. Partial rupture; operation performed; hæmorrhage; ligature had slipped off; amputation. Death.

Cases in which ligature of the femoral artery was employed : 27 cases.

Case 1. Complete rupture; ligature in a few hours; rapid gangrene. Death.

„ 7. Complete rupture; ligature in a few hours; gangrene; amputation. Death.

„ 10. Partial rupture; ligature at 5 weeks; gangrene. Death.

„ 11. ditto ditto 3 weeks; ditto. Death.

„ 12. ditto ditto 6 weeks; ditto. Death.

„ 23. ditto ditto 30 hours; ditto. Death.

„ 25. ditto ditto 8 days; ditto. Death.

„ 13. ditto ditto 3 weeks; fever, diarrhœa, &c. Recovery.

„ 14. ditto ditto 8 weeks; gangrene of foot. Recovery.

„ 15. ditto ditto 3 weeks. Recovery.

„ 22. ditto ditto 5 days. Recovery.

„ 34. Ruptured sac; ditto 8 days. Recovery.

„ 35. ditto ditto Recovery.

„ 36. ditto ditto 1 day; gangrene, rapid. Death.

„ 37. ditto ditto 2 or 3 months. Recovery.

„ 38. ditto ditto gangrene. Death.

„ 39. ditto ditto several days. Recovery.

„ 40. ditto ditto 1 day. Recovery.

„ 68. ditto ditto gangrene. Death.

„ 69. ditto ditto 1 day. Recovery.

„ 41. ditto ditto gangrene; amputation. Recovery.

„ 42. ditto ditto 1 day; ditto ditto. Recovery.

„ 43. ditto ditto hæmorrhage; ditto. Recovery.

„ 44. ditto ditto 8 weeks; inflammation and suppuration; amputation. Death.

Case 45. Ruptured sac; ligature at 7 days; hæmorrhage; amputation. Recovery.

„ 46. ditto ditto 7 days; gangrene; ditto. Recovery.

„ 47. ditto ditto 4 days; ditto ditto. Recovery.

Of these, sixteen recovered; but in six, amputation was had recourse to; eleven died—nine, after gangrene; and two, after amputation.

Cases of amputation : 38, in 70 total cases; being 54·28 per cent.

I. Primary amputation: 12 cases; 7 recoveries, and 5 deaths. Recoveries being 57·89 per cent.

Case 3. Complete rupture; immediate amputation. Death.

„ 4. Complete rupture; immediate amputation. Death.

„ 20. Partial rupture; ligature of ruptured vessel without checking hæmorrhage; immediate amputation. Death.

„ 19. Partial rupture; attempts to ligature ruptured vessel; failure; immediate amputation. Recovery.

„ 49. Ruptured sac; compression employed, and could not be borne; amputation. Recovery.

„ 55. Ruptured sac; no previous treatment; amputation. Recovery.

„ 56. Ruptured sac; no previous treatment; amputation. Recovery.

„ 57. Ruptured sac; exploration with lancet; amputation. Death.

„ 59. Ruptured sac; exploration with lancet; amputation. Recovery.

„ 60. Ruptured sac; exploration with lancet; hæmorrhage on following day; amputation. Death.

„ 62. Ruptured sac; exploration with lancet; sudden increase on following day; amputation. Recovery.

„ 63. Ruptured sac; exploration with lancet; alarming hæmorrhage on third day; amputation. Recovery.

II. Secondary amputation: 26 cases; 14 recoveries, 10 deaths, 2 not stated. Recoveries, 53·84 per cent.

Case 2. Complete rupture; ligature of femoral; spreading gangrene; amputation on fifth day. Death.

„ 5. Complete rupture; gangrene; attempts at separation; amputation at seven weeks. Recovery.

„ 7. Complete rupture; ligature of femoral; gangrene; amputation at seven weeks. Death.

„ 8. Complete rupture; gangrene; amputation on fifteenth day. Recovery.

„ 26. Partial rupture; secondary hæmorrhage; infiltration; amputation. Recovery.

„ 27. Partial rupture; secondary hæmorrhage; amputation at about ten weeks. Recovery.

„ 21b. Partial rupture; slow progress; amputation at three months. Not stated.

„ 48. Ruptured sac; compression employed; threatening gangrene; amputation. Recovery.

- Case 52.** Ruptured sac; compression; ligature of femoral; threatening gangrene; amputation. Recovery.
- „ 53. Ruptured sac; compression; threatening gangrene; amputation. Death.
- „ 54. Ruptured sac; compression; threatening gangrene; amputation. Death.
- „ 61. Ruptured sac; no previous treatment; threatening gangrene; amputation. Death.
- „ 51. Ruptured sac; compression; threatening gangrene; amputation. Not stated.
- „ 41. Ruptured sac; compression; ligature of femoral; spreading gangrene; amputation. Recovery.
- „ 42. Ruptured sac; exploration; ligature of femoral; spreading gangrene; amputation. Death.
- „ 46. Ruptured sac; ligature of femoral; spreading gangrene; amputation. Recovery.
- „ 47. Ruptured sac; compression; ligature of femoral; spreading gangrene; amputation. Recovery.
- „ 58. Ruptured sac; no previous treatment; spreading gangrene; amputation. Recovery.
- „ 65. Ruptured sac; no previous treatment; spreading gangrene; amputation. Death.
- „ 67. Ruptured sac; no previous treatment; spreading gangrene; amputation. Death.
- „ 64. Ruptured sac; gangrene arrested and line of demarcation; amputation. Death.
- „ 43. Ruptured sac; exploration; ligature of femoral; hæmorrhage; amputation. Recovery.
- „ 45. Ruptured sac; exploration; ligature of femoral; hæmorrhage; amputation. Recovery.
- „ 66. Ruptured sac; exploration by incision; suppuration; hæmorrhage on fifteenth day; amputation. Recovery.
- „ 50. Ruptured sac; compression; inflammation; suppuration; knee implicated; amputation. Recovery.
- „ 44. Ruptured sac; ligature of femoral; inflammation; suppuration; knee implicated. Death.

ON
THE TRANSFERENCE OF POISONS
FROM THE
BLOOD TO THE ALIMENTARY CANAL.

BY ALFRED S. TAYLOR, M.D., F.R.S.

PHYSIOLOGISTS and toxicologists have long recognised the fact that poisons received into the stomach and intestines found their way by absorption into the blood, and were thence either temporarily transferred to the solid organs, or eliminated by the various excretions. The fact that, conversely, they might find their way into the stomach and intestines from the blood itself, when this fluid is the seat of poisoning, is a truth which is not commonly known, and has hitherto been only doubtfully accepted. The mucous fluids poured into the stomach and bowels must, however, be regarded as media of elimination, although poisons appear to be more frequently and more abundantly conveyed out of the body through other channels.

This question was briefly considered in reference to antimony in a former volume of these 'Reports.'¹

Orfila found arsenic in the alimentary canal of a dog which had been killed in four hours by the application of three grains of the poison to the cellular tissue. In an experiment, Dr. Brinton injected ten grains of tartar emetic, dissolved in four ounces of water, into the superficial femoral vein of a dog. At the end of fifteen minutes it was killed, and antimony was found in the con-

¹ "On Poisoning by Tartarized Antimony," 'Guy's Hospital Reports,' October, 1857.

tents of the stomach.¹ It thus appears that there is not only a transference of arsenic and antimony from the blood to the stomach and intestines, but that this transference takes place with great rapidity.

There was a practical difficulty to the admission of this doctrine of transference in the case of a human being. As the mineral poison was generally introduced into the body by the mouth, and not by a wound or by injection into the blood, the discovery of it in traces in the stomach after some days might reasonably be referred to the residue of a portion which had been swallowed. Thus, arsenic has been found in the stomach a week after it had been taken by the mouth; and in one instance I found antimony in the stomach of a person six days after the last dose, amounting to three grains of tartar emetic, had been taken. Its presence could not here be ascribed to mucous elimination, for the reason that it was not found deposited in any organ; and unless present in the blood or soft organs, there could be no source from which it would undergo elimination. Another objection to the general reception of the mucous elimination of mineral poisons, exists in the fact that the stomach and intestines frequently contain no traces of arsenic or antimony, while these metals are found in the blood, liver, spleen, and other soft organs of the body.

Notwithstanding these apparent objections to the view that poisons are transferred to the stomach and intestines from the organs in which they have been deposited, facts occasionally present themselves which do not appear to be explicable on any other theory.

In a case of antimonial poisoning recently tried at Liverpool ('*Regina v. Winslow*,' Liverpool Summer Assizes, 1860), it was proved in evidence by Dr. Edwards, who conducted with great skill a most difficult investigation, that, after the deceased, Mrs. Ann James, had been removed from any source of administration of the poison, the contents of the stomach discharged by vomiting continued to yield antimony up to the day of her death, *i. e.* for fourteen days after she had been placed in the Infirmary, under proper superintendence. Dr. Edwards's evidence was to this effect: The matter vomited by deceased on the 10th June (the day of admission) yielded a well-marked

¹ '*Poisons*,' 2d edition, p. 409.

quantity of antimony. On the 11th a trace was found; on the 12th and 13th it disappeared; on the 14th there was antimony; on the 15th none. There was none on the 17th and 19th; it reappeared on the 20th, and was again absent on the 21st; but on the 22d, the last day on which the vomited matter was examined, there was a trace. During the whole of this period the fæces and urine were found to contain more or less antimony. Here, then, we have the remarkable fact, that not only may antimony be found in the contents of the stomach up to the twelfth day after the last dose, but the elimination of this metal may assume an intermittent character. The reader will find a notice of this intermitting elimination of antimony in the second edition of my work on 'Poisons,' p. 52.

Was this discovery of antimony in the mucous contents of the stomach of the deceased to be referred to the retention in that organ of any portion of tartar emetic administered previously to the 10th June, or to the mucous elimination of that which was already in the body, but which was rapidly disappearing from the soft organs? It is difficult to suppose, from the known solubility of tartar emetic, that under such constant vomiting the stomach would not have been cleared of the last dose in a much shorter time than a period of twelve days, especially when it is considered that at no time, probably, had more than one or two grains been given to the deceased at a dose. Any intermediate administration, although at first suspected, was negatived, not only by moral circumstances, but by the chemical results. At no time was the antimony found in the vomited matters in more than the merest traces; whereas a fresh administration would have been at once indicated by a marked increase or difference in the amount. In short, the quantity throughout corresponded to that which might have passed off by the secretions; and after death, traces of antimony were discovered in the stomach and intestines, in the spleen, liver, and lungs. The whole quantity, however, left in the body after the period of fourteen days, could not be estimated at more than one tenth part of a grain. This strongly confirms the opinion given at the trial of Palmer, and elsewhere recorded—that antimony does not commonly remain in organs important to life for a longer period than from fifteen to twenty days after the last administration.

If the antimony found in the vomited mucous matters depended on any residuary antimony in the stomach, there is no reason why some should not have been found in them daily. The intermission in the appearance of the metal in the mucous fluids is in favour of its having been eliminated from the blood, at least in the latter part of the illness of deceased.

It would seem, therefore, in Mrs. James's case, that there was no reasonable explanation of the facts, except that the antimony found by Dr. Edwards, was really eliminated in the mucous secretions of the stomach during life. He gave this opinion in his evidence, and thus put an end to a suspicion which had arisen, that the accused person who had seen the deceased once or twice while in the infirmary had taken the opportunity of administering to her one or more doses of the poison.

The views here expressed receive confirmation from some experiments performed by Dr. Pavy and myself in the summer of 1859, and therefore wholly irrespective of the case of Mrs. James.

EXPERIMENT 1.—Dr. Pavy injected a solution of six grains of tartarized antimony into the jugular vein of a dog. The animal was found dead in the morning, within eight hours of the performance of the experiment. Dr. Pavy brought to me the stomach and intestines of the animal. The mucous membrane of the stomach was much corrugated, but there were no marks of irritation, nor any signs of unnatural redness. In the middle portion of the duodenum there was slight redness, and there was injection and ecchymosis about the lower part of the jejunum and ileum. The ileo-cæcal valve was very much injected. The lower half of the large intestines had its mucous membrane highly corrugated and strongly reddened, and the redness of the membrane was particularly marked in the rectum.

The substance of the stomach, with the mucous matter adhering to it, was examined by the process of Reinsch, and a quantity of antimony was extracted, which was calculated at about 1-700th of a grain. Antimony was also found in the rectum in about the same proportion.

EXPERIMENT 2.—July 4th 1859. Three grains of tartar emetic

in solution were injected by Dr. Pavy into the jugular vein of a dog. The animal was found dead, and is supposed to have died in about eighteen hours after the injection. In this experiment, the analysis was confined to—1, the contents of the stomach; 2, the contents of the large intestines, and 3, the contents of the small intestines. The liquids were free from blood, but those of the intestines obviously contained biliary matter. The largest quantity of liquid amounted to six fluid drachms. On the application of Reinsch's process, antimony was distinctly separated from each of the liquids, a well-marked violet film of metallic antimony being obtained on the copper in each case. The quantity was small, probably not exceeding the 1-1000th of a grain in any one instance.

These experiments, therefore, clearly prove by the results that antimony may not have entered the body of a human being by the stomach or bowels, and yet be found both in the coats and in the liquid contents of these parts of the body.

EXPERIMENT 3.—Two grains of tartarized antimony were dissolved in four drachms of water, and injected by Dr. Pavy into the jugular vein of a dog, without apparently producing any effect beyond vomiting. Twenty-six hours afterwards, three grains, dissolved in four drachms of water, were injected into the jugular vein on the other side of the neck. Speedy vomiting was induced; but, in spite of this, the animal died during the night. The appearances were,—a strongly rugose condition of the mucous membrane of the stomach, with slight injection towards the pylorus; the duodenum was slightly injected; the mucous membrane, however, was for the most part pale. The mucous membrane of the lower part of the small intestines, especially in the rugæ, was decidedly reddened. The margin of the ileo-cæcal valve was much injected, and the mucous membrane of the large intestines was reddened in patches. On analysis, antimony was found in the coats of the stomach and of the intestines. There were no contents.

This experiment shows that, whether antimony finds its way into the body by the blood or by the alimentary canal, the appearances present very much the same character, and are chiefly manifested in the cæcum and the large intestines. It is here worthy of remark, that in the case of Isabella Bankes

(*Reg. v. Smethurst*, 1859), and of Mrs. Ann James (*Reg. v. Winslow*, 1860), the parts of the body chiefly affected were the cæcum and large intestines.

ARSENIC.

EXPERIMENT 4.—Dr. Pavy injected into the jugular vein of a dog, a quantity of Fowler's solution of arsenic, corresponding to one grain of arsenious acid. The dog died in about ten or twelve hours. Dr. Pavy delivered to me for analysis—1, the contents of the stomach; 2, the contents of the small intestines; and 3, the contents of the large intestines. Arsenic was found in each of the liquids, by Reinsch's process, in about five minutes. It was deposited on copper, in a steel-blue film. The quantity obtained was in imponderable traces.

EXPERIMENT 5.—June 22d, 1859. Half an ounce of Fowler's solution (corresponding to two grains of arsenious acid), was injected by Dr. Pavy into the jugular vein of a dog. The animal vomited almost immediately, and it died in about eighteen hours. On inspection, the mucous membrane of the stomach and intestines was found intensely injected; in fact, in a state of acute gastro-enteritis, chiefly marked from the stomach to the cæcum. The coats of the stomach and intestines, with the adhering mucous fluids, were analysed, and arsenic was distinctly found in them.

EXPERIMENT 6.—Two drachms of Fowler's solution, corresponding to one grain of arsenic, and two grains of tartar emetic, dissolved in two ounces of water, were injected into the jugular vein of a dog. The animal was found dead within twelve hours.

The mucous membrane of the stomach presented dark-red patches; the upper part of the duodenum and the central portion of the small intestines were also reddened. The mucous membrane of the lower eight inches of the ileum had the dark colour of venous blood. The ileo-cæcal valve and lower part of the rectum were much injected; the cæcum and upper part of the large intestines were only slightly reddened.

The stomach and large intestines were examined by Reinsch's process, and yielded both antimony and arsenic in small quantity.

From these results it appears that arsenic as well as antimony may find its way into the stomach and bowels and their contents, although not taken by the mouth or injected by the rectum. These facts may be of some importance in cases where reliance is placed on the presence of mere traces of either of these poisons in the stomach or bowels, as furnishing evidence of recent administration by the ordinary channels. When arsenic or antimony are found in more than traces in the stomach and intestines, *i. e.* in powder, or in solution in large quantity, no objection can be taken to the medical inference that they have been taken by the mouth. It is impossible to admit that the solid sulphides of arsenic or antimony found in the coats of the stomach or intestines of a body, in a case of exhumation, can have been derived from the metal eliminated by the mucous secretories from other parts.

MISPLACEMENT AND MOBILITY
OF THE
KIDNEYS,
IN REFERENCE TO
THE DIAGNOSIS OF ABDOMINAL TUMOURS.

BY ARTHUR E. DURHAM.

THE diagnosis of the nature and anatomical relations of a tumour, or supposed tumour of the abdomen, is a matter always of importance, and frequently of difficulty. Now the difficulty may, and probably sometimes does arise, from a want of due recognition of the possible abnormalities, as to shape, situation, and mobility, which may be presented by certain of the abdominal viscera, without manifest detriment to the performance of their functions. Some such abnormalities, presented by otherwise healthy kidneys, I propose briefly to describe in the following pages.

Anatomists have long known that the kidneys are liable to certain variations as to form and position, and that such variations may be congenital, or the results of accident or disease. Riolan, writing as far back as 1682, remarks, "Although the kidneys appear to be firmly attached to the loins, they are, nevertheless, not without the power of leaving their positions, of being displaced and falling forwards; sometimes they even come down as far as the lower part of the abdomen. The cause of this arises, not only from the diminution of the fat with which they are enveloped, but also from the fact that, having

become too large and heavy—in consequence, whether of tumours developed in them, or of stones included in their pelves—they are carried down by their own weight, their attachments not being sufficiently strong to retain them in their places.”¹ Many other anatomists and pathologists, both at earlier and subsequent periods, have from time to time referred to the subject, expressed their opinions, and recorded observations of greater or less value. Cruveilhier, for example, after describing the normal position of the kidneys, remarks,—“Most of the changes in their position are congenital.” “One of the kidneys may not unusually be found in front of the vertebral column, or even in the cavity of the pelvis. . . . I have several times found in females, who have worn tight stays, the right kidney, sometimes in the iliac fossa of the same side; sometimes in front of the sacro-iliac synchondrosis; sometimes even in front of the vertebral column, on a level with the adherent border of the mesentery, in the thickness of which it was situated. The kidney thus accidentally displaced enjoys a certain degree of mobility. This displacement of the kidney occurs when, by the pressure exercised by the stays upon the liver, the right kidney is driven out of the depression in which it is lodged on the under surface of that organ. If the left kidney is not so often displaced as the right, it is because the left hypochondrium, occupied by the spleen and the great sac of the stomach, bears with greater impunity the pressure of the stays.” And again,—“It is not very uncommon to find only one kidney, which is almost always formed by the union of the two, by means of a transverse portion crossing in front of the vertebral column, and having its concave border directed upwards. Sometimes the two united kidneys are situated in the right or left lumbar region, or in the cavity of the true pelvis.”² Velpeau, in his “Treatise on Regional Anatomy,”³ observes,—“The position and attachment of the kidney are subject to numerous anomalies. I have seen it in the iliac fossa on one side, and on the sacro-iliac symphysis on the other. In another subject, it was, as it were, floating in the pelvis. I have fre-

¹ Translated from the ‘Manuel Anatomique et Pathologique’ de Jean Riolan, Lyons, 1682.

² Translated from the ‘Traité d’Anatomie Descriptive.’

³ Translation by Hancock, p. 236.

quently found the two united in front of the spine." It is needless to multiply quotations. Almost every work on anatomy contains some general notice of such abnormalities; and, scattered through the various medical journals are numerous records of individual cases. Moreover, it must have happened, I suppose, to almost every pathologist to have had opportunities of personally examining some such specimens in the post-mortem room, as well as among the preparations in the museum. Notwithstanding the comparative frequency, however, of these irregularities in the position of the kidneys, it was not, I believe, until M. Rayer published his elaborate '*Traité des Maladies des Reins*,' that any attempt was made to give a satisfactory resumé of the facts accumulated, and at the same time to indicate definitely the important practical bearing of the general conclusions established. Since the publication of M. Rayer's work in 1841, the details of numerous fresh cases have from time to time appeared in the different periodicals; and somewhat recently, attention has been especially drawn to the subject by Dr. Hare¹ in this country, and by Dr. Fritz² on the continent. These authors, however, have written particularly upon mobility of the kidneys; and have made only passing allusion to cases in which these organs are fixed in abnormal positions. Now the facts and opinions advanced by M. Rayer, and those who have followed him, have not at present, I believe, met with the general and full recognition they would appear to deserve; and indeed, considerable doubt as to the possibility of some of the affections described, has been expressed by more than one distinguished member of our Profession. I cannot but think, therefore, that the particulars detailed in the following pages, of cases which have recently fallen under my own observation, are possessed of sufficient interest and practical importance to render them worthy of publication, especially when they are considered in connection with the particulars of other cases already published, to which reference will be made.

The abnormalities of the kidneys as to position are divided by M. Rayer, into those in which the misplacement, whether congenital or accidental, is permanent; and those in which the

¹ '*Medical Times and Gazette*, vol. xvi, pp. 7, 85, 112, and vol. i, 1860 p. 30.

² '*Archives Générales de Médecine*,' Aout et Septembre, 1859.

misplacement is not permanent; or, in other words, in which the organs, instead of being fixed, are free to move under the influence of changes in the position of the body, and other circumstances, internal or external.

Amongst the permanent misplacements of the kidneys, the most frequent are those in which the two organs are united by a middle portion lying over the vertebræ, so as to form what is called the "horse-shoe kidney." A great number of examples of this condition are on record. There are two very perfect specimens in the museum of Guy's Hospital,¹ as well as one in which the intermediate portion is comparatively slight. Since the beginning of the year 1854, two other cases have been met with in the post-mortem room at Guy's. In the first of these,² the kidneys were united over the vertebræ by a slight commissure, in which the secretory structure was diminished and pale; the external surface was smooth, and the convexity directed downwards. The second case³ presented a very good example of the "horse-shoe kidney." It weighed thirteen ounces and a-half; and was formed, as usual, by the lower ends meeting over the spine, thus making the convexity downwards. The ureter passed behind the organ. The structure was healthy. Rayer gives references to the records of a great number of cases, and describes three which have fallen under his own observation. He adds, "this anomalous disposition of the kidneys ought to be known to practical physicians; for it might happen that these organs, recognized by the touch, might be mistaken for a morbid tumour and treated as such, especially if met with in a patient who experienced pains in the abdomen from altogether a different cause."⁴

Again, one or both of the kidneys, separate or united, may be situated in the corresponding iliac fossæ, over the sacro-iliac synchondrosis, or even more or less entirely in the true pelvis; and may simulate the tumours that are to be met with in these regions. The importance of the recognition of this fact is well illustrated by the following case:—

Mr. W. S.—, a gentleman residing at ———, enjoyed

¹ Preparations 2023, 2023⁵⁰, 2024.

² No. 52, 'Inspection Book,' 1854.

³ No. 36, 'Inspection Book,' 1859.

⁴ *Traité des Maladies des Reins*, vol. iii, p. 772.

uniformly good health until about his 45th year, when he suffered from a severe attack of fever. During his recovery, he noticed for the first time a tumour deeply seated in his hypogastric region, somewhat on the left of the middle line. This tumour was found, upon examination by Mr. S—'s medical attendant, to be oval in form, somewhat elastic to the touch, and fixed. It was not nodulated, nor did it present any distinctive elevations and depressions. Manipulation gave rise to very disagreeable sensations, but not to acute pain. Considerable alarm was felt by the patient, especially as some members of his family had died from "tumour in the abdomen." In the course of a short time, when convalescence from the fever was established, a second opinion was taken. The conclusion arrived at was, that there existed in the lower part of the abdomen "a tumour of doubtful character." Iodine ointment was applied, and iodide of potassium taken internally. The treatment was continued for some time, but of course did not produce the slightest effect upon the tumour. Mr. S— never thoroughly recovered his health and strength, and about four or five years after his attack of fever, he died of pulmonary disease. My friend Mr. — (the medical attendant) requested me to be present at the post-mortem examination. Upon opening the abdomen, it was at once seen that the supposed tumour was nothing more than the left kidney, which was situated over the sacro-iliac synchondrosis, and extended somewhat on to the promontory of the sacrum, and also by its lower part into the true pelvis. The colon formed no sigmoid flexure in the left iliac fossa, but passed across the middle line; and the commencement of the rectum was on the right side of the sacrum. The supra-renal capsule was large, flat, and in its normal position. The kidney, when divested of the fat by which it was enveloped, was seen to present two depressions, which divided its surface somewhat indistinctly into three portions. One of these depressions extended obliquely across the anterior surface; the other, less distinct, was on the inner and posterior part. The principal arterial supply was derived directly from the aorta, by a branch coming off just above the bifurcation; a branch from the common iliac artery of the *opposite* side, and a branch from the internal iliac of the same side also supplied different parts of the organ. There was one principal

vein, which passed from the internal and posterior part into the vena-cava, just above the junction of the two common iliac veins. The ureter resulted from the junction of four branches; of these two came from the upper and posterior part, while the two principal ones came from the anterior and lower part: these branches joined one another about an inch from their several points of exit from the organ. Thus this kidney presented no distinct hilum, nor consequently did it possess the characteristic kidney-shape. No other anatomical peculiarity was observed. The right kidney was in its normal position. Both kidneys were healthy in structure, and about the usual weight. The misplaced one was kept in its position by a quantity of fat, and a layer of peritoneum, which passed over its anterior surface.¹ This case needs little comment—it speaks for itself. Had a correct diagnosis been made, how much alarm and anxiety the patient and his friends might have been spared, and how much irritating and useless treatment might have been avoided!

With regard to the comparative frequency of such malpositions of the kidneys, it is difficult to form any accurate conclusion. They are certainly not extremely rare, although perhaps not so common as the “horse-shoe” condition.

In the year 1858, I met with an instance in the body of a sailor, who died of phthisis on board the Dreadnought Hospital-Ship. In this case, the renal artery was derived from the aorta, just above the bifurcation, and entered the upper, anterior and inner part of the organ; the ureter passed from the lower and posterior part, and the vein (which entered the common iliac vein of the opposite side) from the inner and upper part. The kidney was the left one, and was situated in front of the sacro-iliac synchondrosis, and almost entirely in the true pelvis. The colon passed across from the upper part of the left iliac fossa, and entered the pelvis on the inner, or right side of the misplaced kidney.

In the year 1859, two cases were met with in the post-mortem room at Guy's. In the first of these, the patient had died from internal strangulation, the consequence of malposition of the intestines. The colon “passed across to the right loin, where the sigmoid flexure occupied the position of the cæcum.” “The left kidney lay over the synchondrosis and sacrum: it

¹ The kidneys and other parts were exhibited to the Pathological Society.

was of an oval shape, with the hilum uppermost, whence came the ureter in front. It was placed over the left iliac artery, close to the bifurcation of the aorta. It was supplied by two arteries—one of which came from the aorta just above it, and the other from the right iliac by its side. The vein passed in front to the vena cava. The corresponding supra-renal capsule occupied its natural position.”¹

In the second case “the kidneys were large, but healthy in structure: the right one was misplaced, lying over the corresponding sacro-iliac synchondrosis. Its vessels came from the aorta at its bifurcation, and from the left iliac. The supra-renal capsule preserved its proper situation and vessels.”²

Thus, within two years, four cases of misplacement of the kidney have fallen under my own observation. Such abnormalities, therefore, cannot be extremely rare. At the same time it must be stated that, on searching through the records of more than one thousand six hundred post-mortem examinations made at Guy’s during the last few years, I have only been able to find the two cases quoted above. There are, however, three old preparations³ in the Museum which may be mentioned. In the first, the “left kidney is situated much lower than usual, and placed upon the vertebræ. It presents a depression in a vertical direction almost dividing it into two.” In the second, the kidney is displaced in consequence of curvature of the spine. In the third (a foetus) “the left kidney is lying in its usual position, while the right is lying in the centre just above the level of the symphysis pubis.”

Rayer gives references to twenty-eight or more cases, and fully describes three. In each of these three it was the left kidney which was misplaced; but in none of them does it appear that the abnormality was noticed until after death. In one of the reports, however, to which reference is made, Dr. Hohl states that he found in the body of a woman “the left kidney deeply placed by the inner side of the Psoas muscle. In two confinements which this woman had had, there was formed, each time (by this kidney) in the left side of the pelvis, a tumour, in which each contraction of the uterus produced fixed

¹ ‘Inspection Book,’ 1859, No. 175.

² Ibid., No. 218.

Preparations 2022⁵⁰, 2022⁵⁰, 2022⁷⁶.

and severe pain: the passage of the head was retarded by it; otherwise the two accouchements were favorable."¹ It does not appear that Rayer has himself met with a case, and in the details he has quoted, no mention is made of the other abdominal viscera. It is, I think, worthy of note that in the cases I have described, misplacement of the left kidney was associated with malposition of the large intestine. The peculiarities in the origin and connections of the blood-vessels and ureter, indicate that in every case the misplacement was congenital, and not the result of accidental circumstances occurring after birth.

It is not only to congenital misplacements, however, that the kidneys are liable. They may be displaced by a variety of causes acting at different periods of life: such as the growth of tumours, morbid enlargements of other of the abdominal viscera, pressure exerted upon the liver and other organs by tight-lacing, &c. Such displacements are by no means uncommon, and examples have probably been met with in the post-mortem room by most pathologists. It is of course possible that, during life, attention might be called to cases of this kind; but the presence of some manifest cause of displacement of the kidney would usually indicate to the experienced practitioner the possible existence of such a condition.

The remaining class of cases to which reference must be made, is that in which the kidneys are not only *misplaced* or *displaced*, but are capable of being moved easily from one position to another. Such cases are probably more common than is usually supposed. Rayer² gives full particulars of nine cases, and states that many others not mentioned in detail have fallen under his observation. In four cases, post-mortem examinations were made. Dr. Hare³ has carefully described five out of seven cases in which he has diagnosed this abnormality during life: the report of one of these is furnished by Dr. Gibb, under whose care the patient eventually came. And various writers,⁴ among whom may be mentioned Velpeau, Nelaton, Öppolzer, and others on the Continent, and Johnson,⁵

¹ Rayer, op. cit., vol. iii, p. 774.

² 'Gazette Méd. de Paris,' 1846; 'Gazette des Hôpitaux,' 1854, and Op. Cit.

³ 'Medical Times and Gazette,' 1857 and 1860.

⁴ Vide Dr. Fritz's paper in the 'Archives Générales,' 1859, p. 160.

'Medical Times and Gazette,' 1860.

Adams,¹ Jago,² and Carnley³ in our own country, have contributed to our knowledge on the subject by the publication of individual cases.

Now, mobility of the kidneys is by no means a dangerous, much less a fatal affection, and consequently opportunities rarely occur of verifying by post-mortem examination the diagnosis of this condition made during life. We may thus explain why the possible existence of the abnormality in question, has not been so generally recognised as it otherwise might have been: nevertheless, I cannot but think there is sufficient and indisputable evidence, not only of its possible, but of its actual, existence; and that, too, in cases in which the diagnosis has been made before death.

Now an examination of the means by which the kidneys are normally retained in their respective places shows at once that they may be rendered moveable to a considerable extent by slight modifications in the anatomical arrangements of the surrounding parts: and, indeed, it seems as though they owe their comparative immunity from accidental displacement to the security of their positions, rather than to the means by which they are fixed therein. Situated deeply in the lumbar region and very near to the spinal column, each kidney is surrounded by loose areolar tissue, more or less filled out with fat, and is held in its bed as it were by a single layer of peritoneum, which passes over its anterior surface. These are the only means by which the kidney is fixed, and prevented from becoming moveable to the extent permitted by the renal vessels. Now in cases in which the anatomical conditions associated with mobility of the kidney have been investigated by dissection, the arrangement of the peritoneum has been found to be abnormal, and the fat of the lumbar region less abundant than usual. The following instances not only support the general statement thus advanced, but afford illustrations of some of the particular modifications which may be met with in the anatomy of the abdomen, and which are associated with the condition of the kidney under discussion. In some of these cases the affection was diagnosed during life; in others it was not discovered until after death. Two only occurred under my own observation; the others I

¹ 'Medical Times and Gazette,' vol. xiv.

² Ibid., vol. xvii.

³ Ibid., vol. xvi.

venture to quote, not only on account of their interest, but because I believe they are not very generally known.

CASE I.—Upon opening the abdomen of J. C., a female, æt. 34, I observed that the left kidney was remarkably prominent, and not exactly in its proper position. The descending colon also was much nearer the middle line than usual, and instead of forming the sigmoid flexure in the left iliac fossa, turned across the lumbar vertebræ, and passed down into the pelvis on the right side of the sacrum. Upon slightly pressing the kidney, it slipped into its ordinary situation; and, upon further examination, it was found to be moveable, with extreme facility, to a most remarkable extent. By different changes in the position of the body, or by gentle manipulation, the kidney was with equal ease caused to pass up under cover of the ribs, across on to the bodies of the vertebræ, or even somewhat to their right side, and down into the iliac fossa. Upon closing the abdomen, and manipulating the lumbar region, the kidney felt like a smooth, oval, semi-elastic tumour, and slipped from between the fingers when compressed. It was at once manifest that the mobility of the kidney in this instance depended in great measure upon the abnormal arrangement of the peritoneum, necessarily associated with the malposition of the colon. So far, therefore, it must be regarded as having been congenital. When traced from the side of the vertebral column, the peritoneum, instead of passing over the anterior surface of the kidney, only just touched the lower part of its inner border, and then, having formed the descending mesocolon, again touched its outer border. The lesser sac of the peritoneum also, instead of being confined to its ordinary limits, passed so far to the left as to cover the posterior surface of the spleen, and so far downwards as to touch and be reflected from the upper border of the kidney. Thus there was no distinct mesonephron: but the kidney, instead of being supported and kept down by a single layer of peritoneum, was left free to move between and beneath three diverging layers. Upon dissection, it was further found that there was scarcely any fat in the lumbar region, but a quantity of very loose areolar tissue. This absence of fat not only assists in accounting for the mobility of the kidney, but also explains the prominence of its appearance, and the distinct-

ness with which its form could be made out. The renal vessels had their ordinary sources and connections; they were perhaps rather longer and thinner than usual. There were no other anatomical peculiarities than those already described. It is worthy of note that the supra-renal capsule of the left side only moved to a very limited extent with the kidney, but remained fixed in its position by its ordinary means of attachment. It may be added, that I exhibited the trunk of this subject to the Pathological Society of London, before any of the viscera were removed or the parts in any way damaged.

CASE II.—In the report of the second case of misplaced kidney, recently met with at Guy's, and already referred to, Dr. Wilks remarks: "The kidney had no mesentery, but at the same time was more moveable than when in the natural position; and, no doubt, if it had been observed during life, might have been slightly moved."¹ The misplacement and mobility were in this case probably congenital.

CASE III.—Mr. J. Adams reports a case, in which an abdominal tumour recognized during life, proved, upon dissection, to be a moveable kidney. He says: "The only remarkable peculiarity was, that the kidney appeared bound down in its situation more loosely than usual, and the old lady, from having been very fat, had become somewhat thinner, and her integument appeared very lax throughout."² This statement and the absence of other peculiarities seem to indicate that the affection was incidental, rather than congenital.

CASE IV.—An old woman was admitted into La Charité with a strangulated femoral hernia on the right side. Upon examining the right iliac region, M. Velpeau discovered, close to the vertebral column, a tumour which extended into the iliac fossa; this tumour was smooth, and had the form and consistence of a kidney. The corresponding lumbar region did not present its ordinary fulness on manipulation. M. Rayer saw this case, and was satisfied that the tumour was a displaced and moveable kidney. The woman died of peritonitis, and the

¹ 'Inspection Book,' 1859, No. 218.

² 'Medical Times and Gazette,' vol. i, 1857, p. 651.

autopsy showed the correctness of M. Rayer's opinion. The hernia was formed by the cæcum, and the right kidney was so far removed from its normal situation, that its superior extremity corresponded to the last lumbar vertebræ, and the inferior rested upon the ilium. The renal vessels were directed downwards from the aorta and vena cava to the hilum of the kidney.¹ M. Rayer remarks upon this case that he was unable to ascertain whether the displacement of the kidney was consecutive to the hernia, or whether the malposition was congenital. It is, however, most probable, I think, that the kidney was dragged down; or, at any rate, left free to descend by its own weight, in consequence of the displacement of the peritoneum necessarily associated with the hernia of the cæcum. The natural origin of the renal vessels indicates that the malposition of the organ was not congenital.

CASE V.—An active man, æt. 36, came under the care of Dr. Aberle, complaining that he had suffered from dyspepsia and various hypochondriacal symptoms for several years; he was particularly uneasy about a tumour which he found on the right side of his epigastric and umbilical regions. This tumour could be easily felt when the patient was fasting, and in bed, especially when it was pushed forward by pressing his sides. On manipulation it was found to be a firm, smooth body, about the shape and size of a hen's egg, slipping away when pressed by the fingers. The diagnosis being obscure, active treatment was avoided by Dr. Aberle, but was adopted by other physicians subsequently consulted. After a time the patient died of fever, and a post-mortem examination was made. It was found that the tumour was formed by the right kidney, which was very moveable, and passed from its normal situation into the umbilical region, when pressure was made upon the loins. The organ was small but healthy. The ordinary bed of fat was wanting; and the vessels were of unusual length. The pancreas and spleen were larger than usual; the spleen very much so. No mention is made of any abnormal disposition of the peritoneum.² Whether the mobility of the kidney in this case was congenital or

¹ Rayer's, '*Traité des Maladies des Reins*,' vol. iii, p. 790.

² Observation d'une tumeur abdominale: dont le diagnostic était très difficile. '*Bulletin des Sciences Médicales*,' tom. xi, quoted by Rayer.

not, it is difficult to determine. There can be no doubt, however, that it was kept up, if not increased, by the constant manipulation to which the organ was subject.

CASE VI.—A woman, æt. 51, came under the observation of M. Rayer in 1841, complaining of pains in the abdomen and right lower extremity. Five months previously she had been much distressed by a severe pain in the right loin, the kidneys, and the hip. This, however, passed off; but, after a short time, on attempting to raise a large basket, she felt the same pain again. A month subsequently she had a fall, and at the moment experienced a strong dragging sensation, which was much more severe on the right than on the left side. The pain soon extended into the right ham, along the posterior part of the thigh, and even as far as the ankle; it gradually increased in severity, and sometimes seeming to start from the right loin, it extended into the labia majora. Walking, fatigue, and the sitting-posture brought on the pain. When lying upon her back, the patient did not suffer at all; when she turned in her bed, the pain was severe, especially in the kidneys, and about the quadratus lumborum muscle. Pressure on the hypogastrium was not productive of pain, nor was pressure upon the anterior wall of the abdomen, on a level with the quadratus lumborum; but when the hands were placed, one in front, the other behind, just below the false ribs, and four fingers' breadth from the spine of the ilium, a perfectly smooth, slippery, rounded tumour was felt. This was recognised as the lower end of the kidney. When pressure was made, the organ slipped away from under the fingers. Manipulation gave rise to great pain, which extended into the ham. - After having been ten days in the hospital, the patient was seized somewhat suddenly with enteritis and peritonitis, which ultimately proved fatal. After death, the tumour, which had been recognised during life, was easily felt, and moved upwards and backwards. Upon opening the abdomen, the intestines were found matted together by numerous adhesions; the liver was of large size, and descended very low in the abdomen. A narrow and rather thin portion reached to the crest of the ilium. The development of this organ had displaced the kidney, and caused it to assume new relations. Pushed from above downwards, and also from behind

forwards, it had become somewhat superficially placed almost in front of the vertebral column, and in the obtuse angle formed by the junction of the iliac vein with the vena cava. Externally it was embraced, as it were, by the prolongation of the liver, which, however, only covered its outer border, and not its anterior surface. Posteriorly it rested upon the crest of the ilium and the muscles attached thereto. Its inferior extremity extended as far as the middle of the intervertebral substance between the fourth and fifth lumbar vertebræ, and was thus in immediate relation with the anterior abdominal parietes. The simple fact of this alteration in the position of the kidney, explains in great measure its mobility, for its relation to the peritoneum was necessarily different; it was no longer surrounded by fat, and its distance from the origin of the renal vessels was lessened, and thus a greater extent of motion was permitted. The kidney was rather smaller than usual, and slightly modified in form. Its mobility was probably not congenital, but resulted, as we have seen, from the position into which it had been forced by the liver. The supra-renal capsule had not shared the displacement of the kidney, but rested against the superior attachment of the quadratus lumborum. The left kidney was in its normal situation, as also was the corresponding supra-renal capsule.¹

CASE VII.—Dr. Priestley mentions a case in which the existence of a moveable kidney had been diagnosed during life, by Dr. Simpson. Upon post-mortem examination, Dr. Priestley found that “the peritoneum was reflected over the posterior surface of the kidney, giving it thus a mesentery, and allowing it very considerable motion in the right side of the abdomen.”² The peculiar disposition of the peritoneum indicates the congenital nature of the affection in this case.

CASE VIII.—A woman, æt. 47, under the care of M. Louis, in La Pitié, died of pulmonary disease. For some time previously to her death, there was considerable œdema of the right lower extremity and right side of the abdomen, the cause of which was altogether unexplained during life. Upon post-mortem examination, “the left kidney was found in its ordinary

¹ Rayer, *op. cit.*, p. 799.

² ‘*Med. Times and Gazette*,’ 1857, p. 263.

position, but the right presented a remarkable abnormality. The peritoneum, instead of passing over its anterior surface only, enveloped every part except the hilum, and thus formed for it a true mesonephron, which was nearly two inches in length. The kidney was thus floating in the abdomen on a level with the third lumbar vertebra, and on the inner side of the descending colon, which, being distended with gas, pressed it against the inferior vena cava." The moveable kidney was perfectly healthy, as also were the abdominal viscera generally. The right iliac vein was filled with "true areolar or cavernous tissue."¹

CASE IX.—M. Urag reports the case of a woman, æt. 65, who was admitted into the hospital suffering from bronchitis. Upon examining her abdomen, the parietes of which were flaccid and destitute of fat, a reniform tumour was discovered below the anterior border of the right lobe of the liver. This tumour was elastic, and clearly defined; it was convex above and flattened laterally; its long axis was directed downwards and backwards, and it changed its position with the respiratory movements. It could not be turned upon its axis, but could be displaced towards the median line, towards the right lumbar region, and slightly in a downward direction. Manipulation gave rise to considerable pain. In the course of a few weeks the patient died, and a post-mortem examination was made. The right kidney was found situated about on a level with the anterior border of the right lobe of the liver. It was attached to the liver, to the gall-bladder, and to the transverse colon by dense fibrous tissue (probably the result of old peritonitis) which prevented it from being replaced in its normal position. Its convex border was turned upwards, and its superior extremity inwards. The ureter was occluded, in consequence of morbid enlargement of the posterior part of the uterus, and the kidney presented various alterations in appearance and structure due to hydro-nephrosis.²

In this case and the following one the affection was probably incidental.

CASE X.—M. Braun describes a case in which the kidney was

¹ Girard, 'Journal Hebdom.', No. 53, p 445, quoted by Rayer. op. cit.

² 'Archives Générales,' Aout, 1858.

found to be very moveable. Cancerous disease of the uterus had caused obstruction of the ureter, and thereby dilatation of the kidney. In this case the displacement and subsequent mobility of the kidney were doubtless favoured by the ascites which had for a long time existed.¹

I have thus given abstracts of all the detailed cases I have been able to collect, in which abnormal mobility of the kidney has been found upon post-mortem examination. I may add that M. Cruveilhier, in the passage already quoted, and also in his "Pathological Anatomy," refers to this condition as one which has not unfrequently fallen under his observation. Rokitansky also makes reference to the subject. And further, M. Oppolzer states that "in all cases he had the opportunity of examining, the patients dying of some other disease, the kidneys were found healthy; but in these cases there has been observable a deficiency in the cushion of fat, and an extension of the renal vessels."² Such a statement implies that M. Oppolzer has met with several instances, although the particulars are not quoted.

Many cases are on record in which mobility of the kidney has been diagnosed during life, but in which opportunities have not occurred of verifying the diagnosis by post-mortem examination. Such cases demand only a passing notice: for the especial object of the present paper is not to discuss the symptoms presented, and the treatment required during life, by the abnormalities referred to; but simply to adduce pathological evidence of their possible occurrence, and to inquire into the anatomical conditions associated with them. This object is now accomplished to the extent permitted by the paucity, and in some instances the incompleteness, of the cases on record.

The facts before us, though few in number, are sufficient, I think, to suggest, if not to place beyond doubt, the following general conclusions:

1. The kidneys are liable to various abnormalities both of form and position. They may be moveable to a greater or less extent, or they may be permanently fixed in unusual situations.

¹ 'Deutsche Klinik,' 1853.

² 'Medical Times and Gazette,' 1857, vol. i.]

2. Under such circumstances the kidneys may simulate abdominal tumours, and thus give rise to difficulties in diagnosis and errors in treatment.

3. Fixed misplacement of the kidneys is usually congenital, as is indicated among other considerations by the corresponding irregularities presented by the renal blood vessels.

4. The left kidney is more liable to fixed misplacement than the right; and its misplacement is usually associated with malposition of the colon.

5. Mobility of the kidneys may be congenital; but, in the majority of instances, it is probably due to circumstances arising after birth, and may, therefore, be said to be incidental. When congenital it is usually associated with other abnormalities manifestly congenital, such as peculiarities in the arrangement of the peritoneum, or in the origin and distribution of the renal vessels. When incidental, there is usually evidence of the present or past existence of some obvious cause of displacement and subsequent mobility. Associated with congenital mobility of the kidney, we may find a distinct mesonephron, or there may only be such modifications in the arrangement of the peritoneum as are necessarily concomitant with malposition of the colon or some other viscus. Among the causes of incidental mobility of the kidney may be mentioned,—pressure upon the liver by tight stays, old peritonitic adhesions, the dragging of a hernia, frequent pregnancies, hydronephrosis, absorption of fat, &c., &c.

6. The right kidney is more frequently moveable than the left; and women are more liable to the affection than men. This must necessarily be the case; for the right kidney, from its situation and relations, is more exposed to displacement; and women, from their habits, are more likely to suffer from most of the above-mentioned causes.

7. When the kidney is misplaced, the corresponding supra-renal capsule occupies its normal position. And when the kidney is moveable, the supra-renal capsule does not move with it.

ON HERMAPHRODITISM,
AS
ILLUSTRATED (PRINCIPALLY) BY SPECIMENS
IN THE
MUSEUM OF GUY'S HOSPITAL.

BY ARTHUR E. DURHAM.

THE museum of Guy's Hospital is peculiarly rich in examples of the congenital malformations and monstrosities, to which, under certain ill-defined or unknown circumstances, the human subject and the lower animals are alike liable. Some few of these specimens have been already carefully and fully described, and delineated in former numbers of the 'Reports,' or in other publications; but the majority, however interesting, have hitherto received only bare mention, or at least very brief description, in the pages of the catalogue; and are therefore known to none, but those who have explored for themselves the crowded shelves of our museum.

Now the science of teratology is not only invested with considerable interest to the philosophical anatomist, but is capable, I believe, of revealing many principles of great practical importance,—and, further, it is a science in which general conclusions cannot be educed, except from a very large accumulation of details, in themselves apparently dry and uninteresting. I propose, therefore, in the present and forthcoming numbers of the 'Reports' to describe the specimens already in the museum, together with others that may come especially under my observation, from time to time, and to submit such general remarks as may suggest themselves.¹

¹ Any specimens sent to the Museum, Guy's Hospital, will be carefully dissected and studied.

The present paper is devoted to certain abnormalities of the genital organs, and the associated peculiarities of the body generally. Such abnormalities are peculiarly interesting, both on account of the rarity of their occurrence, and the strange incidents and still stranger stories to which they may give rise. And much more, because an extended knowledge of them may afford some clue to the conditions which determine the sex of the foetus.

The following cases are arranged in order proceeding from the slighter, to the more remarkable, deviations from the natural condition. Cases of epispadias and extroversion of the bladder, of which we have several examples, are omitted, inasmuch as they appear to pertain to the urinary, rather than to the sexual system.

CASE I.—The first case to which I allude is that of a patient, recently under the care of Mr. Cooper Forster, in Luke Ward. The penis of this man was small and short, the glans uncovered by the prepuce, and the orifice of the urethra rather further back than usual. The corpus spongiosum only existed in a rudimentary condition. The scrotum was remarkably undeveloped; the testicles consequently were higher up and further apart than usual; and the parts appeared more like large labia than scrotum. The left testicle was rather lower than the right. The imperfect penis was bound down, and when in a state of turgescence, became directed downwards and backwards towards the anus. Coitus was thus rendered impossible, and even turgescence (we cannot say erection) of the organ was painful. The man, however, was about to be married. Naturally enough, he was very anxious that some attempt should be made to render his member to a certain extent efficient. At his urgent request, therefore, that something should be done, Mr. Forster made a V-shaped incision through the skin of the anterior part of the perineum, and drew up the penis. The operation was not attended with success, and the patient left the hospital in an unimproved condition. The testicles were of the ordinary size. The man was strong, muscular, and except in the particulars mentioned, well developed.

CASE II.—A very similar deficiency in the organs of a child

four or five years old was shown to me by my friend Dr. Betts, of Watford. In this, as in the preceding case, the glans was bare or only partially covered, the corpus spongiosum rudimentary, the frænum wanting, the scrotum very small, and the penis bound down. The orifice of the urethra was slit-like, transverse, and about an inch from the extremity of the glans. A slighter deficiency of the same kind existed in the organs of an elder brother of this child.

In neither of these instances could there arise any doubt as to the sex of the individual. In the next case, however, the sex was actually misrepresented during life, and only positively determined by examination of the body after death. The following particulars are for the most part quoted from Dr. Hodgkin's report in the post-mortem records of Guy's Hospital.¹ The mammæ and genital organs are preserved in the museum.²

CASE III.—Mary Cannon, between fifty and sixty years of age, was admitted into Guy's Hospital in a delirious state, and died in the course of a few hours without having become sensible. This individual was said to have worn masculine attire in early life, and to have acted as groom, milkman, &c. "For the last seven years *it* had passed as a female," and lived, curiously enough, at the sign of the "World turned upside down," as barmaid and general servant. "Though the master of the house had no knowledge of *its* doubtful sex, he knew that suspicions were entertained by *its* fellow servants, who took care to assign *it* a separate bed. *It* made light work of clearing the tap. In former years, *it* had been accustomed to pugilistic encounters. *It* was much addicted to drinking, and would at times desert *it's* employment for weeks together."

The body was robust; the features coarse and apparently "intermediate between these of an old man and an old woman. The chin and upper lip were sparingly supplied with irregular collections of stiff curling hairs." The breasts were large for a man, but small for a woman. The pelvis and general contour of the body were intermediate in appearance. "By some the male, and by others the female characters were thought

¹ 'Eighth Green Inspection Book,' p. 85.

² Preparations 2545³⁵, 2431⁵⁰, See also Cast 2819^a.

to predominate. There was a pretty considerable quantity of hair about the pubes." Below the symphysis was a penis-like organ, two inches and a half in length, having a naked glans: it was bound down along the median line. About an inch from its extremity was the obliquely truncated orifice of the urethra: and about half an inch anterior to this a blind opening. On each side of the penis-like organ was a protuberance, the skin over which was loose, corrugated, and covered with hair. Within these protuberances small bodies were felt, which upon examination proved to be testicles resembling those of a child between six and seven years of age. The tunica vaginalis extended some distance along the cord, but was completely closed at the abdominal ring. The left vas deferens was cut through, and found to be pervious. The vesiculæ seminales were small, so also was the prostate. A small cremaster muscle was present; and a distinct and pretty strong band of muscle passed over the side of the prostate.

CASE IV.—During last winter session a male subject, presenting in several respects a nearer approach than Mary Cannon to the feminine type, was brought to the dissecting-room at Guy's. The genital organs and mammæ are preserved in the museum. Of the history of this subject I could learn nothing, except that he was twenty-five years of age, and "very like a girl in his manner."

The general appearance of the body was decidedly feminine. The skin was soft and delicate, the face free from hair, the hair of the head fine, the shoulders sloping, the limbs rounded, and the fingers tapering. There was a plentiful supply of superficial fat. The alæ of the pelvis were expanded, like those of a woman; but the arch of the pubes was narrow and angular, like that of a man. The bones generally were thin and light. The most remarkable peculiarity was presented by the mammæ, which in size and structure resembled those of a well-developed adult female. The galactiferous ducts, and the gland structure generally, could be made out as readily as in the breasts of a virgin. The organs were not enveloped in much fat. The nipples and areolæ were like those of the young virgin. The penis was very small, short, and turned down; the glans was partially bare and the frænum remarkably broad. Altogether

the organ looked, at first sight, more like a large clitoris than a penis. There was, however, a corpus spongiosum perforated by the urethra; the orifice of which was rather underneath the glans. The scrotum was short. The testicles were of ordinary size and normal in structure, but they were placed rather more horizontally than usual. Upon the top of each was a somewhat oval, indistinctly lobulated body, enveloped to an equal extent with the testicle by a reflection of the tunica vaginalis. Some

idea of the relative size, shape, and position of this body may be obtained from the accompanying sketch, in which—*a*, indicates the body in question; *b*, the epididymis; and *c*, the testicle.

Upon making a section of one of these bodies, it was found to consist of firm fibrous tissue, containing more or less fat. The tunica vaginalis extended no further along the cord than usual. The spermatic vessels were normal. The vesiculæ seminales were small, so also was the prostate. Thus, although, the general development of the body was that of a woman, the special development of most of the organs of generation was decidedly masculine. The virility of the individual was indicated by the fact that there issued from the urethra a purulent discharge which looked very much like that of gonorrhœa. The natural history of the peculiar bodies surmounting the testes is very obscure. I cannot help thinking, however, that they may be regarded as the rudiments of ovaries, which, instead of developing Graafian vesicles, &c., had degenerated, and become more or less filled out with fat. This idea was suggested to my mind by a specimen I had the opportunity of examining, in which there were bodies surmounting the testicles similar to those I have described, but containing no fat, and presenting much more striking resemblances to normally developed ovaries. The subject, too, from which they were taken had always been supposed to be a woman, and no doubt was raised on the subject until after her death. Such an idea as I have suggested is, however, apparently opposed by the homological relationship which exists between the testicles and ovaries.

In all the cases above described (though not in the one just alluded to), the male development had proceeded to the closure of the median perineal fissure. In the succeeding cases, however, the arrest of development, or rather, the change in its special tendency, must have taken place at earlier periods; for in all of them we find more or less perfect representations of the vagina of the properly-developed female.

CASE V.—I am indebted to my friend Dr. Betts, of Watford, for my acquaintance with the following case:—

Martin——, formerly Martha ——, was christened and brought up as a female. About the age of puberty, and probably from the awakening of desire, *she*, or (perhaps we ought to say) *he* began to suspect that some mistake had been made. In the course of

a short time suspicion became certainty. Accordingly, name and attire were changed, and the girl Martha was converted into the man Martin.

The genital organs of this individual presented the following peculiarities:—The penis was very small, and bound down. The corpus spongiosum was rudimentary. The glans was bare, and notched at the extremity, but not perforated by the urethra. The prepuce was represented by two folds of skin and mucous membrane, which passed down from the sides of the organ, and resembled the nymphæ of the female. Altogether the organ looked much more like a large clitoris than a small penis. Instead of a scrotum there were two large labia, each of which contained an organ, supposed to be a testicle; the left extended rather lower than the right. Between the labia was a fissure about an inch and a half or two inches in depth. The opening of the urethra was situated in the upper part of this fissure, just below the glans of the penis-like organ.

This individual was alive a year or two ago, and in business as a pastrycook and confectioner. The general appearance was that of a very effeminate man. A careful sketch of the genital organs was kindly given to me by Dr. Betts, and is now in the collection belonging to Guy's Hospital.

CASE VI.—Between twenty and thirty years ago a person believed by himself, or herself, to be a woman, and dressed as such, came to Guy's Hospital with the view of having some improvement effected in the sexual organs previous to marriage. This individual was about twenty-five years of age, and had acted for some years as a female servant. He, or she, was on the point of being married, although free from all sexual passion.

The aspect of the face was remarkably intermediate between that of a man, and that of a woman. There was a little down on the upper lip. The voice resembled that of a boy thirteen or fourteen years of age. The figure generally was feminine. The slope and roundness of the shoulders were feminine. The arms presented no distinctive characters. The hands were decidedly masculine. The character of the pelvis was not well marked, but the buttocks and thighs were those of a woman.

The legs might have belonged to either a man or a woman, but they were terminated by ugly masculine feet. There was some considerable fullness in front of the pubes, and the hair extended upwards from this part as high as the umbilicus. There was a large clitoris, or very small penis, the glans of which was uncovered. The prepuce was rudimentary. The penis-like organ was slightly grooved, but not perforated by the urethra. There did not appear to be any corpus spongiosum. Below the penis-like organ was a slit about an inch long, and through this the finger could be introduced to the depth of an inch and a half, or more, into what appeared to be a vagina. On each side of this was a large labium, in which could be felt a small oval body, supposed to be a testicle. It need scarcely be said that no operation was performed. Whether the intended marriage was accomplished or not, I am unable to ascertain. The individual was seen accidentally from time to time, for several years afterwards, but was finally lost sight of, and no further information could be obtained.

For most of the particulars of this case I am indebted to Mr. Towne, by whom a wax model of the parts, and a plaster cast of the whole figure, were executed. These are now placed in the anatomical department of our museum.

CASE VII.—Among the old preparations in our museum is one,¹ described in the catalogue as “the lower part of the body of a child, regarded as hermaphrodite, but which, on dissection proved to be a male.” Neither further description nor history is given. The specimen itself was imperfectly dissected. Upon examining it and pursuing the dissection, I was able to make out many remarkable particulars, some of which are represented in the accompanying plate.

The clitoris (Fig. 2, *c.*) is perhaps, rather large for so young a child as this must have been, but otherwise bears no closer resemblance to a penis than does the ordinary female organ. The nymphæ are united above the glans clitoridis, and for a short distance below it on either side. Below the clitoris is a fissure, in which open (fig. 2, *d*) the meatus urinarius, and (fig. 2, *b*) a canal, which must be regarded as representing the

¹ Preparation 2545.

vagina. This canal is a quarter of an inch or more, in diameter, and leads into a dilated oval pouch (fig. 1, *b*), situated between the rectum and bladder. The walls of the pouch are distinct, and appear to consist for the most part of tissue, which, when examined by the microscope, resembles imperfectly-developed non-striated muscle. The organ itself may be regarded as representing uterus or prostate, according as the subject is considered to be male or female. The general outline of the pouch, the comparative thinness of its walls, and the size of its cavity are points in which it differs almost equally, both from uterus and prostate. No other representative, however, of either of these organs is to be found. To the morphology of this pouch I shall again refer, and for the present proceed with the description, which, so far, is that of a female. All the remaining organs, on the other hand, are decidedly male. In the upper part of each labium is a body, (fig. 2, *d*), the size, shape, connections, and microscopic structure of which prove it to be a testicle. The epididymis of each side is small, and comparatively undeveloped. The vasa deferentia (fig. 1, *d*), are to a certain extent pervious, take their ordinary course, and terminate on the top of the pouch (fig. 1, *b*). Whether they open or not into the cavity of the pouch I have not satisfactorily determined. The vesiculæ seminales (fig. 1, *c*) are small, and overlie (that is, are situated in a plane slightly posterior to) the vasa deferentia. Neither ovaries nor Fallopian tubes are to be found.

The sex of this subject appears to be curiously intermediate between the male and female. There can be little doubt, however, that had the child survived, it would have been regarded as a woman. The anatomical peculiarities of the case are very similar to those described by Professor Ricco as having been found in the body of Maria Arsano: an individual who had been married as a woman, and of whose sex no suspicion was raised during the eighty years of her life.¹

Now, it is by no means improbable that such maldevelopments are more common than is ordinarily supposed. It may be that we do not more frequently become cognisant of them, simply because dissection alone can prove their existence; and the proportion of

¹ See Dr. Simpson. Article on "Hermaphroditism," in Todd's 'Cyclopædia of Anatomy and Physiology.'

bodies dissected is very small. Instances are not uncommon in which reputed women bear no children, even when married to husbands of unquestionable virility. In many such cases no causes of sterility are discovered during life, and no opportunities of examination after death are afforded. It cannot be considered impossible that, if such opportunities were afforded, the explanation in a certain number of instances might be found in the existence of such developmental peculiarities as are described above. It is, at any rate, well known that "masculine women," as a rule, have comparatively feeble sexual desires; and that among such occur the most frequent examples of unexplained sterility. A similar explanation may be given of those cases which from time to time come under the observation of the surgeon or physician, in which reputed women have remarkably small and imperfect vaginae. Two or more cases of this kind have attended as patients at Guy's Hospital within the last few years; and I know of another case in private, in which attempts at artificial dilatation were long persevered in.

I cannot conclude the present paper without making some further allusion to the morphology of the "pouch," mentioned in the case last detailed.

It is well known that at an early period in the development of the generative organs of the embryo, the *sinus uro-genitalis* becomes divided into a *pars genitalis* and a *pars urinaria*. The *pars genitalis* may be regarded as the early stage of the "Weberian organ." In the embryo which is to be male there soon appear, upon the upper part of this organ, two small protrusions, which ultimately become connected with the vasa deferentia, and develop into the vesiculæ seminales. The organ itself is subsequently surrounded by the glandular and non striated muscular tissue which constitute the prostate; and its cavity, which never increases to any extent, is represented in the fully developed subject by the sinus prostaticus. In the embryo which is to be female, on the other hand, the "Weberian organ" undergoes a still further development, forms the vagina, and takes part with the coalesced extremities of the Fallopian tubes in the formation of the uterus.¹ Now, in the case under consideration, it appears as though, in its earlier stages, the

¹ On this subject, see 'Cyclop. Anatomy and Physiology,' article "Vesicula prostatica."

“Weberian organ” had neither been prevented, as it were, from increasing in size proportionately with other parts by the development around it of prostatic tissue, nor yet had been incited, as it were, to pass into a higher stage by the simultaneous development of Fallopian tubes, and enabled to do so by its junction with them; but as though it had simply gone on growing, and finally assumed the condition and appearance of the pouch described. Thus, this curious and apparently anomalous body may be regarded as an early stage of a Weberian organ which has undergone simple increase in size and dilatation instead of becoming imbedded in prostate, or developing into vagina and uterus.

In conclusion, I would only further remark that the study of cases of hermaphroditism affords important aid in the determination of the mutual homological relations which exist between the male and female organs. The following is the view most in accordance, I think, with the cases on record.

Ovaries	= Testes.
Round ligaments	= Vasa deferentia not pervious.
Fallopian Tubes	= Vesiculæ seminales.
Sinus pocularis and openings into it of the common seminal ducts, in so far as they belong to the vesic- ulæ seminales	} = Vagina and cavity of Uterus.
Clitoris	
Nymphæ	
Labia majora	
	= Penis.
	= Prepuce.
	= Scrotum.

At present I merely mention this view of the morphology of the organs, inasmuch as it is illustrated by the cases I have detailed; the discussion of the subject must be deferred to a future opportunity.

PLATE

Illustrating Case VII in Mr. Durham's paper on Hermaphroditism.

Fig. 1 represents the parts as seen on longitudinal section. The section is made on the left of the median line.

- a.* The rectum.
- b.* The "pouch," supposed to be the "Weberian organ" abnormally developed. The probe is passed into it by the canal, the orifice of which is shown at *a*, Fig. 2.
- c.* The vesiculæ seminales.
- d.* The vasa deferentia.

The line of separation between the pouch and bladder is not quite so strongly marked in the specimen as in the drawing.

Fig. 2 gives an anterior view of the external organs.

- c.* The clitoris. Below this is the fissure into which open at
 - a.* The meatus urinarius, and at
 - b.* The canal representing the vagina, and leading into the pouch (*b*, fig. 1).
- d.* The testicle of the left side.

The position of the right testicle and the projection formed by it, are indicated in the drawing.

The median fissure appears to have been somewhat extended by the knife of the dissector.

24

Fig.1

1

2

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4

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AN ACCOUNT OF GUY'S HOSPITAL WELL.

BY WILLIAM ODLING, M.B., F.R.S.

IN 1858, it was determined to sink a deep well at Guy's Hospital, which should yield a quantity of excellent water sufficient to supply the entire wants of the institution. The well, with its appurtenances, namely, two capacious tanks at a considerable elevation, a pair of pumps for raising the water from the well into the tanks, mains for distributing the water over the premises, standcocks in case of fire, &c., was planned and constructed by Mr. R. W. Mylne, C.E., F.R.S. The situation of the well is in the laundry-yard, facing the wash-house, and within a few feet of an eight-horse steam-engine, which serves the double purpose of working the well-pumps, and the machinery employed in the laundry. The well was commenced in the winter of 1858, and completed in the summer of the following year. Its total depth from the surface of the yard is $297\frac{1}{2}$ feet, its depth down to the chalk 197 feet, and consequently its depth into the chalk $100\frac{1}{2}$ feet. The level of the yard is two feet above Trinity high-water mark. The following table gives an enumeration of the principal strata gone through, with their respective thicknesses, in feet:

	Feet.
<i>a.</i> Made ground	12
<i>b.</i> Peat	2
<i>c.</i> Gravel	24
<i>d.</i> London clay	63
<i>e.</i> Red and yellow mottled clay	24
<i>f.</i> Blue shelly clay	7
<i>g.</i> Red mottled clay.....	10
<i>h.</i> Sand and clay, with pebbles	15
<i>i.</i> Grey sand.....	44
<i>k.</i> Chalk	100½
	297½

The relations of these strata to one another, and to the well, are shown in the accompanying section, furnished by Mr. Mylne.

Under the made earth (*a*) were found some Roman remains, including a couple of Samian vases.

The peat bed (*b*) consisted chiefly of dark clay, and contained, in addition to some remains of bone and wood, a few fir-cones of large size, and in good preservation.

The gravel (*c*) was mostly composed of rounded and angular flint pebbles with sand. A few bones were here and there observed in it. This bed furnished an abundance of water.

The London clay (*d*) occurred as a stiff, tenacious clay of the usual dark colour, and presented very little variation throughout. Nodules of septaria, or cement-stone, and some marine shells, were occasionally met with.

Then followed, in descending order, a series of red and yellow mottled clays (*e*), of a more or less indurated character.

Next came a bed of dark clay (*f*), containing numerous fluviatile shells, chiefly belonging to the genus *Cyrena* (*C. cuneiformis*). This was underlaid by a thin stratum of more compact clay (*f*), containing oyster-shells, and this again by another bed of mottled clay (*g*). Then came a thick bed of greenish sand (*h*), with a few rounded pebbles interspersed throughout.

These beds, from the base of the London clay downwards, belong to the Woolwich and Reading series, as described by Mr. Prestwich, and represent similar beds found almost superficially in those localities. They are often referred to as constituting the plastic clay.

The lowest bed of the tertiary strata consisted of gray sand (*i*), the equivalent, probably, of the Thanet sand, which, in other districts, is also found overlying the chalk. This gray sand yielded an abundance of water; indeed, it is not unfrequently resorted to as a source of water supply. It is observable, that a considerable number of the beds, which sometimes, in various localities, separate the London clay from the chalk, are represented in the strata pierced by this well.

The chalk presented the usual characters of white chalk. Its surface was covered with a layer of black and green-coated flints. Other layers of flint occasionally recurred to the depth

at which the boring was discontinued. The different strata are referrible to the geologic periods shown below :

Made earth.....	Historic.	
Peat	Recent.	
Gravel.....	Pleistocene	} Tertiary.
London clay	} Eocene	
Woolwich and Reading beds.....		
Thanet sands		
Upper chalk	Cretaceous...Secondary.	

The upper part of the well, through the gravel and two feet into the London clay, is lined with cast-iron cylinders, three quarters of an inch thick, and four feet in internal diameter. There are six of these cylinders resting upon one another by strong internal flanges, through which they are packed and bolted together, so that the land-spring water of the gravel is completely cut off from the well. The next ninety-seven feet and a half, extending from the upper part of the London clay to the lower part of the second bed of mottled clay, is steined in nine-inch cemented brick-work. Through this passes the bore-pipe, twelve inches in internal diameter and 117 feet long. It extends downwards from the base of the brickwork for seventy-one feet and a half, the last seven and a half of which penetrate the chalk. From this point the boring is continued for the remaining ninety-three feet of chalk, by a twelve-inch augur.

By means of two pumps, of four inches and a half diameter and eighteen inches stroke, the water is raised through a four-inch main, and delivered, at the rate of forty gallons a minute, into two tanks, situated respectively in the old and new hospitals. The tanks are constructed of cast iron, and covered in. That connected with the old building has a capacity of 16,000 gallons, and is placed at a height of sixty feet from the ground. The other has a capacity of 8000 gallons, and is at a height of eighty-four feet from the ground. Two one-inch-and-a-half mains from the larger tank, and one two-inch main from the smaller, descend to supply the hospital and adjacent buildings connected with it. The average daily consumption of water in the institution is not less than 13,000 gallons.

The maximum water-level observed in the well is sixty-one feet and a half below Trinity high-water mark, or sixty-three

feet and a half below the surface of the yard. Hence this well cannot be called with strict accuracy an Artesian well, the term Artesian being properly restricted to spouting wells, that is, to such wells as yield their water at, or above, the level of the ground. The maximum water level, just referred to, usually occurs on every Monday morning, and results from the water being allowed to accumulate for thirty-six hours. With this exception, the water rarely rises to within less than sixty-five feet from the surface, that is, about twenty-two feet above the upper extremity of the bore-pipe, and twenty-five feet above the extremities of the suction-pipes, the last three feet of which, however, are perforated. Hence the water supplied to the smaller tank has to be raised to a height varying from 151 to 171 feet; and that supplied to the larger tank to a height varying from 127 to 147 feet.

The supply of water, though fully sufficient for the wants of the institution, is not so ample as was originally anticipated. At first the pumps might be worked continuously for eight, or even ten hours, without exhausting the supply. At present, the exhaustion is readily effected by two hours' pumping. The well, however, refills itself in the course of an hour, and will then allow of another hour and a half's pumping; and this alternate resting and pumping may be carried on throughout the day.

The water supplied by the well is bright and colourless to the eye, brisk and pleasant to the taste, and has a marked alkaline reaction to test-paper. Its temperature, when fresh from the well, was found to be 54° , that of the atmosphere being 65.5° F. When boiled, the water becomes slightly turbid, from the deposition of the carbonates of lime and magnesia, which the excess of carbonic acid, driven off by ebullition, formerly held in solution. When boiled down to half its bulk, the clear water, filtered from the deposit, does not afford any evidence of the presence of either lime or magnesia. It has still, however, a strong alkaline reaction from the carbonate of soda which it contains. This filtered water, when slowly evaporated, yields a white, saline residue, in which crystals of chloride of sodium, and sulphate and carbonate of soda may be readily distinguished by microscopic examination. The residue left by the evaporation of the water to dryness, undergoes,

when heated to redness, a slight charring, from the presence of a small proportion of organic matter, but does not evolve any ammoniacal vapour recognisable by delicate test-paper. In addition to the constituents already mentioned, the water was found to contain some potash-salt, minute quantities of phosphoric acid, iron, and alumina, and a scarcely perceptible trace of nitric acid, but no ammonia. The sp. gr. of the water at 60° F., is 1000·77. Its total solid contents amount to 51·69 grains per gallon. This residue is composed of the following constituents in the quantities indicated :

SEPARATE CONSTITUENTS.	Grains per gallon.
Chlorine.....	9·75
Sulphuric acid	9·24
Carbonic acid.....	6·90
Silicic acid.....	0·79
Lime	1·47
Magnesia	1·15
Soda	13·87
Sodium	6·32
Potash	0·66
Phosphate of iron and alumina	0·05
Organic matter	0·94
Total by summation	51·14
Total by direct experiment	51·69

A sufficient amount of sodium to combine with the whole of the chlorine was calculated as sodium, the remainder as soda. The phosphate of iron and alumina was determined as follows : A portion of the water was evaporated to dryness, and the residue, after ignition at a low red heat to destroy the organic matter, treated with an excess of hydrochloric acid. This was expelled by evaporation, and the dried residue heated to about 250° to separate the silica. The resulting mass was then treated with strong hydrochloric acid, and dissolved in hot water. A few drops of nitro-muriatic acid were next added to oxidize the iron, after which the solution was filtered. The filtrate was precipitated with a slight excess of ammonia, and the whole gently heated. After standing for a night, the pale ochrey precipitate was collected on a filter, washed, dissolved in

hydrochloric acid, reprecipitated by ammonia, collected on a filter, washed, dried, ignited, and weighed. The ignited mass was then treated with a little carbonate of soda to render it soluble, and dissolved in hydrochloric acid. Phosphoric acid, alumina, and sesquioxide of iron, were detected in the resulting solution. There was more than sufficient iron and alumina present to carry down the whole of the phosphoric acid. The organic matter was estimated by evaporating a portion of the water to dryness at 250° , then igniting the residue for some time at a low red heat, moistening it with water, treating the moist mass with carbonic acid for several hours, and then again drying at 250° . After this restoration of the carbonic acid, driven off from the lime and magnesia, the loss on ignition was considered to be organic matter. This method of determination, introduced by Dr. Clark, though not rigidly accurate, is, I believe, the best at present known. The other estimations were made in the usual manner, and do not call for any remark. The numerical details of the different determinations are given below. Each result is the mean of two concordant experiments.

A. Determination of total fixed constituents.

	Amounts of water taken.	Fixed residue found.	Amount per gallon.
I.	14,000 grs.	10.360 grs.	51.800 grs.
II.	17,500 grs.	12.895 grs.	51.580 grs.
			<i>Mean</i> 51.69 grs.

B. Determination of organic, or combustible matter.

	Amounts of water taken.	Loss on ignition.	Amount per gallon.
I.	14,000 grs.	0.200 grs.	1.000 grs.
II.	17,500 grs.	0.220 grs.	0.880 grs.
			<i>Mean</i> 0.94 grs.

C. Determination of chlorine.

	Amounts of water taken.	Chloride of silver found.	Equal to chlorine.	Amount per gallon.
I.	7,000 grs.	3.930 grs.	0.972 grs.	9.720 grs.
II.	8,750 grs.	4.940 grs.	1.222 grs.	9.776 grs.
				<i>Mean</i> 9.75 grs.

D. Determination of sulphuric acid (anhydrous).

	Amounts of water taken.	Sulphate of baryta found.	Equal to sul- phuric acid.	Amount per gallon.
I.	7,000 grs.	2.720 grs.	0.934 grs.	9.340 grs.
II.	8,750 grs.	3.330 grs.	1.143 grs.	9.140 grs.
				<i>Mean</i> 9.24 grs.

E. Determination of carbonic acid (anhydrous).

	Amounts of water taken.	Carbonic acid found.	Amount per gallon.
I.	14,000 grs.	1.360 grs.	6.800 grs.
II.	17,500 grs.	1.750 grs.	7.000 grs.
			<i>Mean</i> 6.90 grs.

F. Determination of silicic acid (anhydrous).

	Amounts of water taken.	Silicic acid found.	Amount per gallon.
I.	14,000 grs.	0.155 grs.	0.775 grs.
II.	17,500 grs.	0.200 grs.	0.800 grs.
			<i>Mean</i> 0.79 grs.

G. Determination of lime.

	Amounts of water taken.	Carbonate of lime found.	Equal to lime.	Amount per gallon.
I.	7,000 grs.	0.260 grs.	0.146 grs.	1.460 grs.
II.	8,750 grs.	0.330 grs.	0.185 grs.	1.480 grs.
				<i>Mean</i> 1.47 grs.

H. Determination of magnesia.

	Amounts of water taken.	Pyrophosphate of magnesia found.	Equal to magnesia.	Amount per gallon.
I.	7,000 grs.	0.320 grs.	0.116 grs.	1.160 grs.
II.	8,750 grs.	0.390 grs.	0.142 grs.	1.136 grs.
				<i>Mean</i> 1.15 grs.

I. Determination of the alkalies.

	Amounts of water taken.	Chlorides of sodium and potassium.
I.	14,000 grs.	8.613 grs.
II.	17,500 grs.	10.892 grs.

K. Determination of potash (anhydrous).

	Amounts of water taken.	Platinochloride of potassium found.	Equal to potash.	Amount per gallon.
I.	14,000 grs.	0.690 grs.	0.133 grs.	0.66 grs.
II.	17,500 grs.	0.860 grs.	0.166 grs.	0.66 grs.
				<i>Mean</i> 0.66 grs.

L. Determination of soda (anhydrous).

	Amounts of water taken.	Chloride of sodium found.	Equal to soda.	Amount per gallon.
I.	14,000 grs.	8.402 grs.	4.452 grs.	22.260 grs.
II.	17,500 grs.	10.629 grs.	5.632 grs.	22.528 grs.
				<i>Mean</i> 22.39 grs.

M. Determination of phosphate of iron and alumina.

	Amounts of water taken.	Phosphate found.	Amount per gallon.
I.	188,510 grs.	0.140 grs.	0.052 grs.
II.	98,630 grs.	0.070 grs.	0.049 grs.
			<i>Mean</i> 0.050 grs.

In the evaporated residue, the acid and basic constituents of the water seem to be combined with one another, somewhat in the manner indicated below :

COMBINED CONSTITUENTS.	Grains per gallon.
Chloride of sodium	16·05
Carbonate of soda.....	12·36
Sulphate of soda	15·21
Sulphate of potash	1·33
Carbonate of lime.....	2·62
Carbonate of magnesia.....	2·37
Silica	0·79
Phosphate of iron and alumina	0·05
Organic matter	0·94
Total residue.....	51·72

It is observable, however, that the mode in which the different constituents are combined in the residue, affords no information as to the mode in which they are combined in the water itself. It appears probable, indeed, that, in the water, every acid is united with every base, so as to form the greatest possible number of salts, the amount of each different salt formed being dependent conjointly upon the relative masses and affinities of its constituents. Even the arrangement of the different constituents of the residue, to form definite salts, is to some extent a conventional affair. Thus, in the above statement of results, the silica is placed apart, in accordance with ordinary custom. It was ascertained, however, that in the dried residue of the water, and still more in the considerably evaporated water, a portion of the silica existed in the state of silicate of soda, and doubtless the silica in the natural water was also present in that form. The magnesia, again, is set down as a mono-carbonate; whereas, neither in the water, nor the residue, does it really exist in that state, but in the former as bicarbonate, and in the latter as three fourths carbonate. The water is but sparingly ærated. The total quantity of carbonic acid in a gallon was found to be, as a mean of two concordant determinations, 13·98 grains. Deducting the 6·90 grains of fixed carbonic acid, we have an excess of 7·08

grains, or just sufficient to convert the neutral carbonates into the state of bicarbonates, so that practically the water contains no free carbonic acid. There were also present in a gallon of the water 5·49 cubic inches of nitrogen, and 0·91 cubic inches of oxygen gas, measured at mean temperature and pressure. The low ratio of the oxygen to the nitrogen is probably due to a portion of the originally-dissolved oxygen having been expended in oxidation, during the percolation of the water through the earth. The water of which the above-described analysis was made, was taken from the well on May 16th, 1860. Another sample was taken on July 23d, 1860. The total residue in this second sample was found to be, as a mean of two experiments, 50·84 grains,¹ including 0·7 grain of combustible matter. In the interval between the taking of the samples, there had been more than seven inches and a half of rainfall, which may possibly have had to do with the slight diminution in the amount of solid contents yielded by the water.

This well water belongs to the class of soft waters. Its hardness, as determined by Dr. Clark's soap-test, is only 5·5 degrees, and this, by boiling, is reduced to 1·5 degree. The average hardness of Thames water, as formerly supplied to the hospital by the Southwark and Vauxhall Water Company, is 14 degrees, which, by boiling for a quarter of an hour, is reduced to 6 degrees, and even this water is justly considered to be a very excellent one. The quantities of soap requisite to produce an equal lather with the two waters, being directly proportionate to their respective degrees of hardness, it is obvious that a considerable economy must result from the substitution of the well-water for Thames water in laundry operations. Moreover, the carbonate of soda in the well-water greatly increases its detergent capabilities. The presence of this salt is also an advantage when the water is used for tea-making, and is generally thought to be an advantage when it is used for brewing. On the other hand, it must be remembered, that carbonate of soda is a medicinal agent, though not a very powerful one, and that a person drinking half a gallon of the water daily in the forms of water, tea, beer, &c., is taking a dose of five grains and a half of carbonate of

¹ Dr. Taylor examined the water in October, 1859, and found it to yield 47 grains per gallon of fixed residue.

soda daily, in addition to seven grains and a half of sulphate of soda. A person drinking the same quantity of unboiled Thames water daily, would receive but a somewhat smaller amount of antacid into his system; only that, in this case, the base would be lime instead of soda. The antacid effects of boiled Thames water, however, are quite inappreciable. Although the well water does yield a deposit on boiling, yet the amount of that deposit is very much less than that furnished by Thames water. Thus the well water contains about five grains in a gallon of the carbonates of lime and magnesia, which are precipitable by boiling, while Thames water contains twelve or thirteen grains of these carbonates, in addition to about three grains of sulphate of lime, which deposit on evaporating the water, and serve to bind the precipitated carbonates into a hard, compact, adhesive mass. Hence the deposit, in boilers and tea-kettles, from the well water, is much less in quantity, and more manageable in character, than that from the river water. Thames water, as supplied by the principal London companies, is well known to be, on account probably of the sulphate of lime which it contains, devoid of any action upon lead. This well water has a slight action upon the freshly scraped metal, but none whatever upon ordinary plumbers' lead. Moreover, in the hospital, leaden fittings are to a considerable extent avoided.

The following table furnishes a comparison of the composition of Guy's Hospital water, with that of Thames water from Ditton. The analysis of this last water is taken from Messrs. Graham, Miller, and Hofmann's report to the Home Secretary on the supply of water to the metropolis.

CONSTITUENTS.	Thames Water.	Guy's Water.
Chloride of sodium	1·10	16·05
Carbonate of soda	—	12·36
Sulphate of soda	—	15·21
Chloride of potassium	0·67	—
Sulphate of potash	0·17	1·33
Sulphate of lime	3·06	—
Nitrate of lime	0·27	—
Carbonate of lime.	11·79	2·62
Carbonate of magnesia.....	1·27	2·37
Silica.....	0·62	0·79
Phos., iron, and alumina	0·09	0·05
Organic matter.....	2·29	0·94
Total grains per gallon	21·33	51·72

I am inclined to think that the amounts of organic matter in both waters somewhat exceed the average quantities. It is observable that the objectionable qualities of Thames water are greatly reduced by boiling, whereby the carbonates of lime and magnesia are removed, and completely obviated by the additional use of commercial soda, whereby the sulphate of lime is decomposed, and the resulting carbonate of lime precipitated.

In the following table, the analytical results obtained with Guy's Hospital water, are compared with those obtained with some other deep-well waters in London, to which allusion is now about to be made :

CONSTITUENTS.	I.	II.	III.	IV.	V.	VI.
Chloride of sodium	16·05	12·7	19·04	10·53	13·92	14·30
Carbonate of soda	12·36	11·6	11·37	8·63	10·92	6·73
Sulphate of soda	15·21	24·25	20·27	13·14	10·75	15·69
Sulphate of potash	1·33	...	1·33	...	2·10	1·92
Carbonate of lime	2·62	6·18	2·74	3·50	4·14	5·39
Carbonate of magnesia ...	2·37	1·08	2·07	1·50	2·98	3·20
Silica	0·79	0·44	0·40	0·50	0·70	0·60
Phosphate of iron and } alumina }	0·05	0·43	0·97	} traces.	traces.	traces.
Organic matter	0·94	...	0·66			
Total grains per gallon	51·72	56·80	58·85	37·80	45·41	47·83

No. I is my analysis of Guy's Hospital water.

No. II is Mr. Graham's analysis of the water from Messrs. Combe and Delafield's well in Long Acre. In his analysis, the phosphoric acid was considered to be in combination with both iron and lime ; so that the 0·43 grain, in the table, should be set down to phosphate of iron and lime, instead of to phosphate of iron and alumina.

No. III is Mr. Dugald Campbell's analysis of the water of the Orange Street well, from which the fountains in Trafalgar Square are supplied. I have made a trifling alteration in the arrangement of his results, so as to make them comparable with my own.

No. IV is Mr. Brande's analysis of the water of the Mint.

No. V is my analysis of the chalk spring water, and

No. VI my analysis of the sand spring water, from a deep well at Mr. Burnett's Distillery, in Vauxhall.

Some of the constituents of these waters are highly interesting in a scientific point of view. The presence of potash in deep-well water was first ascertained in the case of the Artesian water of Grenelle, near Paris, which, moreover, is quite free from soda salts. The fixed constituents in a gallon of this water, as estimated by M. Payen,¹ are shown below :

CONSTITUENTS.	Grains per gallon.
Chloride of potassium	0·763
Bicarbonate of potash	2·072
Sulphate of potash	0·860
Carbonate of lime.....	4·760
Carbonate of magnesia.....	0·994
Silica.....	0·399
Organic matter.....	0·015
Total residue	9·863

Mr. Graham was unable to detect potash in Messrs. Combe and Delafield's well, nor could Mr. Brande recognise its presence in the water of the Mint. It has, however, been found in the Trafalgar Square water, by Messrs. Abel and Rowney, by Mr. D. Campbell, and by Dr. Dupré and myself. In their analysis of Trafalgar Square water, Messrs. Abel and Rowney estimated the amount by sulphate of potash present at the extremely high amount of thirteen grains and a half per gallon. Moreover, potash has been detected by several chemists in various other deep-well waters of the London basin ; there was no difficulty in recognising its existence in the Guy's Hospital water. I am quite unable to account for the irregularity of its presence in waters derived from the same strata, and at situations comparatively near to one another. It does not appear to depend upon the different depths of the borings.

The presence of phosphoric acid in deep-well water was first

¹ 'Annales de Chemie et de Physique.' 3ème sér., tom. i, p. 381.

ascertained by Mr. Graham in his examination of the water of Messrs. Combe and Delafield's well in 1845. This acid has since been invariably found, when sought for, in the deep waters of London. Its presence is not surprising, for phosphoric acid is a compound, of which minute quantities are very widely distributed in nature. It exists in the deep-well waters in variable, but always in very small, proportions. The amount of phosphoric acid which I found in Guy's Hospital water, is considerably less than that which other chemists have found in the waters of other deep wells. The estimation, however, was made very carefully, and corroborated in several ways. When nitrate of silver is added to an aqueous solution of the fused residue of an evaporated deep well water, an abundant precipitate is produced, the yellow colour of which is at times very decided. This yellow colour has been considered to result from the phosphoric acid existing in the water. In my opinion, the quantity of phosphoric acid present is, in no case, anything like sufficient to account for the coloration, which, I believe, is really dependent upon the carbonate of soda. In adding nitrate of silver solution to the solution of an alkaline carbonate, whenever the drop of nitrate of silver is temporarily in excess, we always obtain a yellow precipitate, as is indeed well known. Phosphoric acid is also found in the water of shallow wells, or land-springs of the London gravel; but, in this case, it is doubtless derived from contamination of the water with products of animal decomposition, and is associated with obvious quantities of other compounds of similar origin, ammonia, nitric acid, &c.

The source of the carbonate of soda which exists so uniformly, and to so considerable an extent, in the deep waters of London, has been the subject of much speculation, and is even now undecided. The general opinion at one time entertained was, that it resulted from the admixture, and mutual reaction, of infiltrated sea water, rich in soda salts, with proper chalk water, containing much bicarbonate of lime. The principal arguments in favour of this view were considered to be the following: Water from chalk wells, situated above the level of Trinity high-water mark, the Watford water for instance, is comparatively free from soda salts, which exist so largely in sea water; whereas these salts are found to a considerable

extent in the water of chalk wells descending greatly below high-water mark, such as the deep-well water of the London basin. Again, the high chalk water, though poor in soda salts, is rich in carbonate of lime, whereas the deep chalk water is comparatively rich in soda salts, and poor in carbonate of lime; and this difference in character has been thought to indicate mutual decomposition of the soda salts of the sea, with the carbonate of lime of the proper chalk water, whereby carbonate of soda is produced in the deep-well water. Moreover, it has been stated that the proportion of soda salts in the deep-well water of London was gradually increasing, a circumstance which, it was conceived, could scarcely occur unless that water had some communication with the sea. The above view has been controverted, and, as I think, successfully, by Mr. Dugald Campbell.¹ He has shown that the alleged increase of soda salts in the deep-well water is a mistake; that the shallow chalk water contains an obvious amount of nitric acid which is not to be found in the deep-well water; and finally, that no admixture of proper chalk water and sea water could account for the composition of the deep-well water as a whole. The following table of the principal constituents of the different waters, calculated, No. 1, from Mr. D. Campbell's analysis of the Watford water; No. 2, from my own analysis of the Guy's Hospital water; and No. 3, from Mr. Schweitzer's analysis of the water of the English channel, illustrate Mr. Campbell's position. If the sodium of the deep-well water, for example, had been derived wholly from the sea, it ought to have been associated with at least 25·63 grains, instead of with only 9·75 grains of chlorine.

CONSTITUENTS.	I.	II.	III.
Chlorine	0·84	9·75	1366·75
Sulphuric acid	0·39	9·24	164·99
Carbonic acid	8·00	6·90	1·01
Calcium	7·71	1·05	29·86
Magnesium	—	0·69	97·32
Sodium	0·77	16·61	744·69
Potassium	—	0·54	28·03

¹ 'Quarterly Journal of Chemical Society,' vol. ix, p. 22.

In reference also to the above view, it is worthy of observation that the deep chalk water of Southampton, which appears to be contaminated to a considerable extent with sea water, is entirely free from carbonate of soda.¹ In addition to other constituents of the sea, this water contains 62·8 grains of common salt in a gallon, whereas the Trafalgar Square water contains only 19·0, and the Guy's Hospital water only 16·0. Mr. Campbell has also shown the improbability of a modification of the above view, namely, that the deep-well water results from an admixture of the proper chalk water with sea water, which has undergone a change by percolating through an immense bed of chalk.

In the present imperfect state of our knowledge, the most probable explanation of the source of the carbonated alkali in the deep water of London, seems to me to consist in recognising the decomposition of an alkaline silicate, chiefly silicate of soda, existing in the strata above the chalk. The presence of carbonated alkali in the deep water of Grenelle, which is free from salts of the sea; and the presence of salts of the sea in the deep water of Southampton, which is free from carbonated alkali, seem to negative the idea that the existence of carbonated alkali in certain deep-well waters is dependent in any way upon contamination with sea water. That it may be derived from alkaline silicates is rendered probable by the following circumstances, namely, that alkaline silicates are among the most common constituents of minerals, and are known to suffer slow decomposition by the action of water containing carbonic acid, rain-water for example;² and that carbonate of soda is not confined to the deep-water from the chalk, but exists also in the water of the porous strata intervening between the London clay and the chalk. On a preceding page, the analyses of two waters from Mr. Burnett's well at Vauxhall are given. This well is so constructed, that the water of the gray sand above the chalk can be obtained separately from the water of the chalk itself. No. V is the analysis of the chalk water, and No. VI that of the sand

¹ Robson, 'Quarterly Journal of the Chemical Society,' vol. iv, p. 7.

² A portion of the sand stratum overlying the chalk, obtained from the borings of Guy's Hospital well, was found to contain a considerable proportion of a readily decomposable silicate of soda.

water. It will be observed that the general characters of the two correspond closely, the principal difference being that the chalk water contains more carbonate of soda, and less sulphate of soda, than does the sand water. This is a difference which may be readily explained, by supposing the sulphate of soda of the sand water to undergo a partial decomposition with the bicarbonate of lime, which characterises a pure chalk water. Moreover, it is quite possible that the formation of carbonated alkali, begun by the decomposition of alkaline silicates in the plastic clay and gray sand, may be continued by the decomposition of alkaline silicates in the chalk. My results with the gray sand water are not singular; Mr. D. Campbell examined a specimen of well water from the plastic clay, and found it to correspond closely in its characters with deep-well water from the chalk. Messrs. Clarke and Medlock again, in their examination of the Westbourne Park well water, observe, "the almost complete identity of water from the sand and that from the chalk." I notice, however, in their analyses, as in my own of Mr. Burnett's well waters, that the sand spring water contains more sulphate of soda and less carbonate than the water from the chalk. I am inclined to think that the principal source of the deep-well water of London is rain water, a considerable proportion of which has drained through the highly porous sand formations beneath the mottled clay, into the chalk, which constitutes its principal reservoir. Mr. Burnett, indeed, seems to obtain about one eighth of his entire supply direct from the sand springs. The porous eocene beds, intervening between the London clay and the chalk, have a very extensive superficial distribution for the reception of rainfall. On the south, they are found in Kent, at Woolwich, Blackheath, and Bromley, &c.; and in Surrey, beyond Croydon, and at the Addington Hills. To the north of London, they appear at the surface in parts of Hertfordshire, and of Middlesex, particularly in the neighbourhood of Bushey. This view of the source of the carbonate of soda in deep-well water does not account in any way for the presence of the chloride of sodium. It is not contended, however, that the well water is entirely free from sea-contamination, but only that sea-contamination is not the cause of its alkalinity. From the fact of portions of the chalk, and

of the much more porous strata above it, cropping out as we proceed eastwards along the course of the Thames to the sea, it seems not improbable that the deep water of London should be contaminated to some extent with sea water. The deep water of the Paris basin, indeed, is free from sea salt; but then the direct distance of the chalk under Paris from the sea, the altered relations to the sea of the littoral chalk itself, which, in some parts eastwards, rests upon a bed of Kimmeridge clay, forming a portion of the sea-bottom, and the non-communication of any porous strata above the chalk with the sea, render the case of the Paris basin very different from that of London, as regards its liability to sea-contamination. Moreover, at Grenelle, the boring has pierced through the chalk, and entered the lower green-sand formation, from which, I believe, the supply of water is principally derived.

The waters of the different deep wells in London have a very similar composition to one another; and the composition of the water of any particular well is found to vary but little from time to time. The following table gives the total solid contents per gallon yielded by several of the deep wells in London and its neighbourhood, and also by those of Southampton and Grenelle. It is observable that, in the great majority of London waters, the total solid contents per gallon vary from about thirty-five to sixty grains only. The result of Dr. Dupré and myself with the Trafalgar Square water is the mean of two examinations, one made in the early spring before, and one in the early autumn after, the great summer rainfall. The estimations were respectively 59·26 and 57·68 grains of residue per gallon.

Site of Well.	Grains of residue per gallon.	Date of analysis.	Name of analyst.	Total depth in feet.	Depth into the chalk in feet.
Trafalgar Square	66·10	1846	Brande.	400	133
" "	69·40	1847	Abel and Rowney.	"	...
" "	61·60	1850	D. Campbell.	"	...
" "	58·85	1855	"	"	...
" "	58·97	1860	Odling and Dupré.	"	...
Combe and Delafield's Brewery ...	56·45	1845	Graham.	522	304
Royal Mint	37·80	1849	Brande.	426	202
Apothecaries' Hall.....	45·00	...	"	...	...
Notting Hill	60·60	...	"	...	...
Berkeley Square	60·00	1847	"	316	90
Goding's Brewery, Lambeth.....	50·00	1848	"	330	80
More's Brewery, Old Street Road...	38·00	1849	"	350	195
Tilbury Fort	75·00	1849	"	...	...
Barclay's Brewery.....	46·50	1850	"	367	130
Surrey County Prison	19·00	1852	"	...	...
Bank of England	48·20	1854	D. Campbell.	...	...
Reid's Brewery, Liquorpond street .	50·40	1853	"	...	...
Beaufoy and Co.'s No. 1 Well	30·69	1859	"	372	171
" " No. 2 Well	31·12	1859	"	211	10
Guy's Hospital.	51·69	1860	Odling and Dupré.	297·5	100½
Burnett's Distillery, Vauxhall	45·41	"	"	325	105
Hampstead Waterworks	40·11	1848	Mitchell.	538	160
Holt's Ratcliffe Brewery	35·40	1849	"	215	...
Westbourne Park	56·68	1853	Clarke and Medlock.	230	...
Russell Square	47·75	"	"	230	...
Hanwell Lunatic Asylum	47·96	"	"	235	...
Colney Hatch Lunatic Asylum	32·97	1850	Noad.	...	...
Southampton.....	91·17	1850	Robson.	1280	700
Grenelle	9·86	1841	Payen.	1794	...

By way of contrast to the comparative uniformity of the deep-well waters, I append some results, obtained by Dr. Dupré and myself, with the waters of several shallow wells situated in the district of Lambeth.

No.	LOCALITY, &c., OF WATER.	Grains, per gallon, of Solid Matter.		
		Organic.	Mineral.	Total.
1	Pump by Hercules Public House, Kennington Road ...	4.5	85.9	90.4
2	Ditto by Triangle, Lower Kennington Green	4.5	92.6	97.1
3	Ditto in Prince's Road	5.2	92.0	97.2
4	Ditto in Church Street, Waterloo Road	6.0	86.1	92.1
5	Ditto by Victoria Theatre, Waterloo Road	7.8	97.3	105.1
6	Ditto in Duke Street, Stamford Street	17.9	104.2	122.1
7	Ditto by Licensed Victuallers' School, Kennington Lane	6.3	57.3	63.6
8	Ditto by corner of Brook Street, Walcot Place East . .	14.2	88.8	103.0
9	Ditto in Kennington Oval	6.2	75.0	81.2
10	Ditto at Vauxhall Cross.....	2.8	73.3	76.1
11	Ditto by Lambeth Terrace, Lambeth Road	10.8	112.1	122.9
12	Ditto by corner of Chester Street, in Kennington Road	7.9	86.7	94.6
13	Ditto by Surrey Lodge, in Kennington Road	32.9	75.5	108.4
14	Ditto in York Road	7.0	96.0	103.0
15	Ditto in Coldharbour Lane	5.9	43.6	49.5
16	Ditto in Bond Street, Vauxhall Cross	4.8	82.3	87.1
17	Ditto in Lorn Road, North Brixton	7.8	61.2	69.0
18	Ditto in James Street, Kennington Park	8.6	66.8	75.4
19	Ditto in St. Ann's Road, North Brixton	6.2	51.8	58.0
20	Ditto in Loughborough Road, Brixton.....	14.1	60.5	74.6
21	Ditto in High Road, Herne Hill, Brixton.....	1.2	20.4	21.6
22	Ditto in Portland Place, Clapham Road	5.7	63.4	69.1
23	Ditto in the Oval Road	9.9	77.6	87.5
24	Spring Well, near the Stag Inn, Wandsworth Road ...	11.6	91.7	103.3
25	Pump at Vestry's Office of Works, Kennington Green...	16.0	54.4	70.4
26	Ditto in Yard at Rectory House, Church Street	1.9	27.4	29.3
27	Ditto at a Private House, Kennington	1.6	22.1	23.7
28	Ditto in Yard at Licensed Victuallers' School	4.4	80.0	84.4

Thus, in the shallow waters furnished by this limited area, the organic, or combustible, matter was found to vary from one to nearly eighteen grains, and the saline, or mineral, matter from twenty to one hundred and twelve grains per gallon. These waters not only vary much from one another, but also from time to time. They are almost always rich in organic matter, and contain obvious quantities of ammonia and nitric acid, products of animal decomposition. Many of them, when pumped down, furnish a liquid which is little else than filtered sewage. Moreover, they are usually very hard waters, from the presence of sulphate and carbonate of lime.

In conclusion, I have to express my thanks to my friends, Professor Morris and Dr. Dupré, who have afforded me much information, and rendered me valuable assistance, in the preparation of this paper.

CONTRIBUTIONS TO THE PRACTICAL SURGERY
OF
NEW GROWTHS OR TUMOURS.

SERIES III.—CYSTS (*continued*).

By JOHN BIRKETT.

IN the last volume of these 'Reports,' I reported cases in illustration of those cysts which are developed in relation to the tegumentary tissues of the body. When describing the cysts which are seen on the inside of the lips and beneath the tongue, I omitted to refer the reader to some cases recorded by Mr. Poland in this serial.¹ In that communication he demonstrates the fact that the sublingual cysts there described had no communication with the sub-maxillary duct, and also that the contents of the labial cysts closely resembled the fluid contained in the sublingual. Also, he there relates two cases² in which the sub-maxillary gland itself was very much enlarged in consequence of its ducts being occupied by a calculus. In these cases of obstruction of the duct, let it be observed, there were no cysts developed; but in the cases where the canal of the duct was free, as proved by passing a probe along it, sublingual cysts existed.

III. CYSTS IN THE CONNECTIVE TISSUE OF THE BODY.

In continuation of the third series I propose now to illustrate, by reports of cases, those circumscribed collections of serous fluid which are found in the connective tissue of various regions of the body, but which seem to select those parts

¹ 'Guy's Hospital Reports,' 1851, pp. 337 to 340.

² Op. cit., pp. 340 and 341. Cases xxii and xxiii.

where the connective tissue is most abundant, or where the various organs of the region are least firmly bound together by the medium of this tissue. Thus, in the neck these cysts are much more common than in any other part of the body. The cyst-wall is usually very thin, and consists of a delicate membrane, the internal surface of which resembles that of a serous membrane, and is covered with pavement epithelium. Numerous minute capillary blood-vessels ramify in the fibre-tissue under the basement membrane, and the contractile fibre-tissue exists therein in abundance. It is, probably, owing to the presence of this element that the very large cysts sometimes met with collapse and contract so completely after their contents have escaped. The term "hydrocele of the neck" has been applied to these serous cysts when developed in that region.

1. *Cysts in the Neck.*—I desire to concentrate the reader's attention upon the cysts developed in the cervical region, and which have no relation whatever with those cysts dependent upon a morbid state of the thyroid gland. Several authors have written of these cysts, and references to the cases are made in the table at the end of this paper. There appear to be two classes: the *first*, of those cases in which a *single* or *unilocular* cyst is found; and, *secondly*, of those in which the morbid structure is composed of several cysts—the *multilocular*.

These cysts are developed at the earliest age. On one occasion an infant was brought to me in which there was every reason to conclude that the development was strictly congenital; for the tumour was observed immediately after birth. Other cases demonstrate that they form in childhood and adult life. Mr. Cæsar Hawkins¹ had drawn the attention of the profession to "a peculiar form of congenital tumour of the neck," consisting of a congeries of cysts filled with serous fluid of different colours, which seems to belong to the second class of the kind of new growth under examination.

Their commencement and subsequent growth are often painless. Indeed, it sometimes happens that the discovery of their very existence is made by an uninterested observer, and not by the patient. Nor until the tumour assumes a considerable size, and encroaches on the surrounding parts, or stretches

¹ 'Med.-Chir. Transactions,' vol. xxii, p. 231, 1839.

filaments of nerves, do patients complain of pain. The size produces inconvenience, and the appearance is unsightly ; but no further complaint is made.

The origin and cause of these cysts is most obscure. Neither anatomical examination of the walls of the cysts, nor of the fluid which they contain, assists to explain their development. The elementary tissues of which they are composed are identical with those of the serous membranes, and, in many cases, their fluid contents, when tested in the ordinary way, show the same changes under the application of heat, or the addition of nitric acid, as the secretion from any serous membrane. I should here state that Dr. A. Richard has published¹ a very interesting dissection of a case of hydrocele of the neck, in which he demonstrates, according to his own view, that the affection originated in the lymphatic ganglia of the region. In the report of the case by M. Lebert, that distinguished pathologist does not consider that the facts warrant the above conclusion, and in this opinion I fully concur. It has certainly crossed my mind whether some of these cysts may not have a communication with the lymphatic vessels, but, in the absence of anatomical proof, it is merely a theoretical assumption. Probably, the analysis of the fluid might establish the fact.

The nature of the fluid contained in the cavity of the cyst differs. In some cases it is quite limpid, colourless, free from odour, and closely resembles spring-water ; neither the application of heat nor the addition of nitric acid producing any change in its outward appearance. Even after standing and exposure to the air, no appreciable change takes place, with the exception of its becoming slightly turbid. In other cases the serum is of a pale-yellow tint, perfectly clear and inodorous. If heated it coagulates, forming often a perfectly solid mass of albumen. The addition of nitric acid produces a similar result. Having remained a short time exposed in a test-tube or glass vessel, a gelatinous mass forms, which, when turned out, is sufficiently firm to retain the shape of the vessel in which it was first placed. Occasionally, and more particularly in the cases of long standing, laminæ or crystals of cholesterine float in the serum, producing a sparkling and remarkable appearance. Such I believe to be the genuine characteristics

¹ *Mém. de la Soc. de Chirurgie de Paris*, t. iii, pp. 38—53, 4to, 1853.

of the serum contained in those cysts, the lining membrane of which has not undergone any morbid change. However, if the part has received any injury from contusion, pressure, or such like external violence, the serum may be tinged with blood; or even mixed with pus-globules. Under these circumstances, the colour varies from red to brown or yellow, according to the amount of admixture. The changes occurring in the external appearance of the fluid, as the result of irritation or inflammation, is well illustrated in Case v. The serum abstracted by the first operation was clear and colourless, by the second it was turbid and light brown, and by the third it was puriform. Also, in Case vi, the brown colour and opacity of the serum are to be explained by the probable admixture of blood and pus, resulting from the blow on the cyst. However, I cannot but think that the marked differences in the physical qualities of the serum indicate some distinct and peculiar sources of origin of these several cysts, which more extended anatomical observation and careful chemical analysis may explain at some future time.

Treatment.—The surgical treatment of the cysts developed in the neck is of two kinds: first, *palliative*, if the patient desires the diminution of the bulk of the tumour only; and, secondly, *the radical cure*, when the sufferer is anxious to be free from the inconvenience entirely.

The palliative treatment consists in removing the serous contents, from time to time, with a trocar and canula. In the performance of this operation, great care should be taken to avoid the wounding of either superficial or deep blood-vessels. The external jugular vein frequently crosses the surface of the cyst, and must be carefully sought for before introducing the trocar, by which it might, by chance, be transfixed. The deep blood-vessels must escape injury if the point of the trocar is directed upwards, and a little outwards.

The radical cure depends upon the extirpation or obliteration of the cavity of the cyst.

1st. Extirpation is performed by dissecting the cyst from the surrounding organs. It is attended often with very great difficulty, and always, when large, with very great risk to the life of the patient. The records of such operations fully corroborate the last assertion. Indeed, in some instances, the

operator has been compelled to desist, and to be content with the removal of a portion of the cyst only. I therefore regard extirpation of the cyst with the knife to be justifiable only after all other measures have failed to cure the disease.

2d. Obliteration of the cavity of the cyst may be induced by exciting inflammation upon its free surface. The result of inflammation is the effusion of an organizable material within the cavity, which unites its walls together. The surgeon has therefore to determine upon the method by which he may best ensure success, with the least amount of suffering and risk to the life of his patient. And let the details of some of the recorded cases impress upon the mind of the student the fact that considerable risk has attended the excitement of profuse suppuration, and the urgent constitutional disturbance attendant thereon. Let the case published some years since, in these 'Reports,' attest the truth of this remark.¹

The most common methods adopted to induce inflammation consist in the introduction of a stimulating fluid into the cyst, after the removal of that which originally filled its cavity; of the insertion of a seton through the walls and cavity of the cyst; of the introduction of lint, charpie, cotton wool, or sponge; the excision of a portion of the sac; and the external local application of tinctures or ointments compounded of an irritating substance.

After the employment of one of the above-mentioned plans, which may be termed the primary proceedings, great attention must be devoted to the local conditions of the surrounding parts, and the constitutional disturbance excited by the inflammation. The local inflammation is often intense. From being at first, for the second or third day, confined to the cyst, it may extend beyond it into the loose connective tissue, and among the important organs of the cervical region, and cause great embarrassment of the functions of deglutition and respiration. Under these circumstances, care must be taken to ascertain that a sufficiently free passage exists for the escape of pus; and if there is only a small opening, or the puncture or incision originally made has closed, a fresh incision must be made to allow the pus to flow freely. The edges of the wound may be kept apart by inserting between them a piece of

¹ 'Guy's Hospital Reports,' vol. i, p. 105.

flexible bougie or catheter, a piece of thin gutta-percha, about an inch wide, or a portion of vulcanized india-rubber tube.

The table of cases, at the conclusion of these remarks, displays briefly the result of the different plans of treatment above alluded to. The plan which I adopted in Cases v and vi seems, however, to have been successful without causing the alarming symptoms related to have occurred in several instances. It consisted in repeatedly emptying the cyst until its walls had contracted, and a sufficient amount of inflammation had been excited to produce a puriform fluid by the external application of the strong compound tincture of iodine, or tincture of Spanish fly, or ordinary blistering ointment. An incision was then made, in order that the pus might escape freely, and the wound was kept open by the introduction of a foreign body. This plan I should again adopt, in preference to any other, as the first proceeding. Should it fail, and if it were expedient to adopt more active measures, the injection of the compound tincture of iodine into the cyst, after the removal of the serum, should be employed. A case of this kind, treated by the injection of tincture of iodine, by Mr. Prescott Hewett, is related in the 'British Medical Journal,' and is also quoted in the table appended to this paper.

In the treatment of these cases it is not always expedient to meddle with them at all; and the judicious surgeon will reflect, before proceeding to undertake the radical cure, whether he is not entailing a greater risk of sacrificing the patient's life by so doing, than by leaving it to nature. The two cases kindly sent to me by my friend, Mr. Rump, are good illustrations of the judgment displayed by that gentleman in the exercise of his profession. Case ii shows that the disease may exist many years, and cause nothing but slight local inconvenience. The simple emptying of the cyst caused great constitutional disturbance, and nothing more was attempted. And now the man is healthy and strong, and the swellings cause no inconvenience. Another case, No. iv, illustrates the fact that those cysts and their contents may progressively diminish, and, although existing many years, that no ill results ensue. I will conclude these observations with a quotation from a very interesting monograph, by Messrs. Fleury and Marchessaux,¹ reminding

¹ 'Arch. Gén. de Méd.,' 3e série, t. v, p. 441, Paris, 1839.

the reader that the advantages and safety of the employment of the compound tincture of iodine were not then so fully appreciated as at the present day.

“Amongst the different means which have been proposed by surgeons to cure this disease, it would appear that puncture and injection ought to be completely rejected. Incision, and the employment of ulterior means, suitable to excite suppuration in the cyst, appear to be the modes to be employed with the greatest advantage in all kinds of cystic tumours of the neck. Excision, practised after a previous incision, is useful when the tumour is very old, and its membrane very thick, because it more certainly excites suppuration than any other means. Lastly, dissection ought not to be attempted, except when the tumour is small, superficial, moveable, and unconnected with the thyroid gland and the important organs in the neck.”

CASE I.—Cyst developed in the cervical region of an infant.

In 1855, a female infant, 14 days old, was brought to my house on account of a large swelling occupying the right side of the neck. It was well developed, healthy, and the third-born. Immediately after birth, the friends observed a swelling at the side of the neck, which slowly increased. The whole of the right side of the neck was occupied by a swelling, divided into an anterior and posterior portion by the sterno-cleido-mastoideus muscle, which could be easily traced as it extended over the anterior surface of the cyst. A circumscribed collection of fluid could be easily diagnosticated; for fluctuation was very marked, and translucency very apparent. The infant did not appear to suffer any inconvenience from the swelling, and the integuments were perfectly healthy. At this tender age I did not consider it prudent to interfere; and I advised the parents to allow it to remain undisturbed. I saw the child two or three times afterwards, when no inconvenience had resulted.

CASE II.—*Cyst in the neck; developed shortly after birth; paracentesis, followed by urgent symptoms.* (See Plate at the end of this paper.)

For the details of this case I am indebted to Mr. Hugh Rump, of Wells-next-the-Sea, Norfolk.

J. C—, æt. 13, a boy residing in a village in Norfolk, was observed, by his mother, to have a small tumour in the neck, just *above* the clavicle. This was soon after birth, and it was about the size of a horse-bean. As the child was remarkably strong and healthy, she did not take much notice of the swelling at the time; but subsequently, as it increased rapidly in size, she consulted a surgeon, who regarded it as a glandular enlargement, and treated it accordingly. At this period it was entirely *above* the clavicle, and, in spite of all remedial measures, steadily augmented in size, forcing itself behind the clavicle; and shortly after a tumour made its appearance in the axilla. This occurred in the autumn of 1848, and I then saw the child for the first time. He had all the appearance of a well-nourished healthy child. A tumour, the size of an egg, occupied the right side of the neck, and extended behind the clavicle; and a tumour of equal size, or perhaps a little larger, filled up the axillary space, bulging forward the pectoral muscle. Compression of either tumour emptied it, or greatly reduced its size, and a corresponding enlargement immediately took place in the other. This proved that a communication existed between the two; in fact, that the cervical and axillary tumours were produced by one common cyst. Fluctuation in both was very perceptible, and the tumour in the neck was translucent. The case being clearly that of hydrocele of the neck, and as the child did not suffer the slightest discomfort, even from the presence of the swellings, I discountenanced all active treatment. Mr. Birkett saw the patient in June, 1850, and, at his suggestion, I inserted a trocar and canula at the lower part, and about nine ounces of fluid flowed. It was clear, limpid, pale-amber colour, and contained a material which gelatinized shortly after removal. The parts were then strapped with adhesive plaister, and compress and bandage applied. This slight operation produced a very severe effect upon the child; great prostration of power ensued, and for a short time

his life was in considerable jeopardy. He appeared much in the condition of a person who was suffering from excessive hæmorrhage, although not a drop of blood was lost during the operation. The failing health of the child compelled me to remove the bandages, when I perceived that the cyst was refilling, and in a short time it was quite as distended with fluid as it had been prior to the operation.

Since the summer of 1850 no treatment has been adopted ; and at the present date, 1860, the patient is a tall, delicate, but most intelligent boy. The tumour in the neck has attained the size of a turkey's egg or a lemon ; and a bi-lobed tumour, of the magnitude of two medium-sized oranges, placed side by side, occupies the axilla. The lad states that he does not experience any inconvenience from the presence of the swellings. His mother says, that during one or two attacks of illness a remarkable diminution in the size of the tumour has occurred, which, on convalescence, again attained its former magnitude.

A case very similar, in its external appearances, to the last, is related by Damen, and he has given a plate of it in his work. He states :

CASE III.—“ Not long since I saw such a swelling on the shoulder of a male child, scarcely five years old, and of which a representation is given in the annexed plate. This child was born on October 19th, 1775, and was brought to my house, by its parents, on the 23d July, this year, with a request that I would examine it and advise as to treatment. The mother said that she had at first discovered the commencement of the swelling on the top of the shoulder when the child was about five weeks old ; that when it had reached the size of a hen's egg, she had shown it to some medical men, who had considered what should be done to make it disperse, but without any result. The swelling had, therefore, increased to its present size. She added that, when pregnant with the child, she had been frightened by a man with a tumour on his neck. The swelling is of the figure and size as represented. It is situated on the right shoulder, between the neck and the highest part of the upper arm ; so that the first part rested upon the right clavicle, the posterior portion on the edge of the scapula ; and

it had extended from the front, along the chest, up to the half of the humerus, where it was nearly as large as that on the top of the shoulder. The swelling is soft to the touch, and appears to contain some matter, the nature of which we cannot state, though probably it resembles that which is found in cases before related. Further, the child appears healthy, although now weakly in form. In consequence of the rarity of such a case in so young a child, I have had it exactly drawn, in the presence of Professor Huybers, who also examined it.”

CASE IV.—*Cyst in the neck ; developed in youth ; progressive diminution.*

Also for this case I am indebted to Mr. Rump.

A married woman, æt. 27, residing in a village in Norfolk, when 17 years old observed, for the first time, a tumour on the right side of her neck. It was then small, but rapidly increased to the size of a walnut. By medical advice, she applied tincture of iodine over the swelling, and took the iodide of potassium regularly for several months. The tumour, however, gradually increased until it reached its greatest magnitude. This was written in November, 1859. It is ovoid in shape, and springs from beneath the right sterno-cleïdo-mastoid muscle, occupying the side and front of the neck, almost to the mesian line. It measures five inches in length, and four across. It is translucent, and, having very thin walls, the fluid contents fluctuate readily. The patient considers that it is steadily, but certainly, wasting and diminishing in size. Formerly most distressing cerebral symptoms were complained of, which appeared referable to an obstruction of the venous circulation in the right side of the neck, produced by the mechanical effects of the tumour. These symptoms have, however, long since passed away, and neither pain nor inconvenience are, at the present moment, ascribable to the tumour. At one time, she was most anxious I should either remove the cyst or do something to obliterate it. I did not feel disposed to interfere with it, as I knew of a case, apparently precisely similar to this, in which a surgeon incised the cyst, and stuffed it with

¹ ‘Heelkundige Waarneemingen aangaande de Gezwellen bekend onder den Naam van Tumores Cystici,’ &c., 8vo, p. 22, Gravenhage, 1780.

lint to arrest a profuse hæmorrhage from its interior. Suppuration subsequently ensued, great constitutional disturbance was the result, and the patient was in a perilous condition for some months. (Refer to Case VIII.)

CASE V.—*Cyst in the neck; developed in adult life; paracentesis; suppuration of cyst; cure.*

The following case is reported by Mr. F. M. Cann.

A labouring man, æt. 39, was admitted, under my care, into Lazarus ward, in November, 1858. He had enjoyed good health, although now his aspect indicated cachexia. He resided in a neighbouring suburb, and had a wife and family dependent upon his labour, the profits of which were very scanty and uncertain. He came to Guy's on account of a large swelling occupying the left side of the neck, situated in and filling up the posterior triangle. He first noticed a small lump behind the left ear four years since. This slowly enlarged and descended, until eighteen months before admission, when it increased rapidly. It was unaccompanied by pain, and even now he only sought relief on account of the unsightliness produced by the tumour. There was manifestly a circumscribed collection of fluid, the skin over which was healthy. The entire surface was uniform; the shape of the swelling ovoid; the cyst was tense, and it projected in bold relief from the surrounding parts. Translucency was obtained by holding a candle to one side and examining the other, with the assistance of the hand to make a shade to the light. Taking all the circumstances into consideration, the disease was regarded to be a cyst with clear serous contents, of the nature of those cases termed, by some writers, "hydrocele of the neck." The man was well nourished for a few days, and then Mr. Birkett performed paracentesis with a trocar and canula. About five ounces of clear, colourless, limpid fluid flowed. Neither the application of heat, nor the addition of nitric acid, produced the slightest appreciable change in this fluid. It did not coagulate after rest. It appeared, indeed, to be completely free from both albumen and fibrin. By this treatment the cyst was entirely emptied. The Unguent. Iodidæ comp. was used to anoint the integuments over the cyst; and tonics, with a generous diet, administered.

Two days afterwards the cyst refilled, and the tumour was as large as before.

In about a month after the operation, the cyst was only partially refilled, and again I emptied it with a trocar and canula. About four ounces of light-brown, turbid serum escaped. The colour was probably due to a slight admixture of blood-corpuscles, resulting from the first operation. The following day I applied a blistering ointment over the surface of the cyst, with the view to inflame it and excite absorption. This application was repeated at intervals. A small quantity of fluid again filled the cyst, but very slowly; and he left the hospital in order to work for his family. In the middle of the following January, he was again admitted, the swelling being about half its original size, and the integuments over its surface slightly inflamed. A third time I punctured it; but, on this occasion, pus flowed—about two and a half ounces. It was thin, and resembled that commonly formed in chronic abscesses. The cyst-wall was thickened, and pressure caused pain. It was clear that a desirable change had taken place; that, in fact, the walls of the cyst were inflamed, and that obliteration of its cavity would ensue. The tincture of iodine was applied, and adhesion of the cyst-walls was progressing when he left the hospital. Since that time, I have not seen the man.

CASE VI.—Cyst in neck; developed in adult life; paracentesis repeatedly; inflammation and obliteration of cyst.

A strong man, æt. 45, a smith by trade, was admitted, under my care, into Lazarus ward, in October, 1859. He had a large swelling occupying the whole right side of the neck, extending from the mastoid process above to within an inch and a half of the clavicle below, and projecting in high relief. The integuments were unaffected, being merely stretched, but not tensely. The fibres of the platysma myoides were spread over the swelling, which clearly consisted of a circumscribed collection of fluid.

The man stated that he noticed a small tumour on the right side of his neck, a little below the angle of the jaw, about thirteen or fourteen years since, which did not then exceed two

inches and a half in diameter. It did not enlarge until about a year since, when, after the receipt of a blow on the region, it rapidly increased until it attained its present dimensions. It had been always painless. The man was out of health. Tonics and generous diet were administered.

A few days after admission I performed paracentesis of the cyst with a trocar and canula, and removed about eight ounces of serous, opaque, light-brown-coloured fluid, in which laminæ of cholestearine floated. After twenty-four hours' rest there was no precipitate from this fluid, or separation of its constituents; but after a few days a clear, serous fluid appeared at the top, from the subsidence of the more solid elements. Slight inflammation ensued in the vicinity of the puncture, which was made at the lowest part of the cyst, and the fluid again collected. After eleven days I again punctured the cyst, and six ounces of fluid escaped, which resembled that before described. The fluid again rapidly collected, and at the lower part, in the neighbourhood of the puncture I had made, suppuration was established, and pus escaped through two small ulcerated openings. At one of these I introduced a director, and about four ounces of fluid flowed out. This was more serous than that which preceded it, and, after standing in a test-tube for a short time, it separated into a stratum of pus-cells and serum, tinged with hæmatine. As the discharge did not flow freely enough to permit the walls of the cyst to fall in contact, and to maintain that position, I made an incision into the lower part of the cyst with a lancet, inserted a piece of gutta percha to keep the wound open, and, having emptied the cyst, applied pressure. This, for a time, effected the object very well; but the insertion of the gutta percha having been omitted, the wound closed, and the fluid again collected in the lower part of the cyst. A vulcanized india-rubber drainage-tube was next inserted, and worn for some weeks. This enabled the secretion to escape freely; and when the man left the hospital, two thirds of the upper portion of the cyst appeared to be obliterated. He subsequently came to the hospital, having a little pus escaping from a sinus; but the cyst seemed to be destroyed.

During the whole and rather protracted treatment of the case, an abundant supply of food, with stimuli, was allowed, and tonic medicines were administered.

With the exception of slight constitutional disturbance at the periods when suppuration took place, no features of any great importance marked the progress of the case. These conditions were met in the usual manner, and they never gave rise to any serious apprehension for the result.

CASE VII.—In 1829, Mr. B. B. Cooper removed a cyst from the cervical region of a healthy man, æt. 21, sent to Guy's Hospital by Mr. Rump, of Wells, Norfolk. It had been growing about eight months, and was attended at first with considerable pain. The excision was attended with great difficulty. The cyst adhered below to the subclavian muscle, and on the inner side to the sheath of the carotid vessels, and in consequence of its depth it was difficult to tell its nature before it was cut into. A considerable quantity of sero-purulent fluid escaped when the cyst was cut open, and at the lower part there was a brain-like substance. The cyst could not be entirely removed; the deepest portion was left, and the wound allowed to heal by granulation. The man returned home well, and at this time, September, 1860, is strong and healthy. This report I give on the authority of Mr. Rump, who kindly sent me the information.

CASE VIII.—The history of a very interesting case has been sent to me by Mr. Hugh Rump. A very strong, robust, healthy gamekeeper was the subject of a tumour in the neck, of very large size. A surgeon operated upon it, and opened a large cyst in the whole extent, emptied it, and stuffed the sac with lint. During the night following the operation the man nearly lost his life from a sudden and most profuse hæmorrhage. The cyst was again emptied, and a large vessel secured by a ligature with some difficulty. Suppuration was established, and very copiously; so much so that the man, remarkable for his stature and strength, very nearly succumbed to its effects. The discharge did not finally cease for two years. He recovered completely at last, however, and is now, about twenty years from the date of the operation, well and healthy.

CASE IX.—*Multilocular cyst in the neck; paracentesis; removal; cure.* (Prep. 1649⁵⁵, Drawing 197⁶⁰.)

A healthy girl, æt. 19, applied to me, in the early part of the year 1851, on account of a swelling which occupied the right side of the neck. She attended for some time as an out-patient at Guy's. Some months before, she observed a fulness behind the lower portion of the sterno-cleido-mastoideus. This slowly increased until a well-defined tumour existed. Fluctuation was very perceptible, and there was no difficulty in arriving at the conclusion that a circumscribed collection of fluid was the cause of the deformity. She did not complain of pain, nor did manipulation cause any. I administered iodine locally and internally, without any benefit resulting. I performed paracentesis and diminished the size of the swelling, without entirely removing it. The fluid which flowed was clear, limpid, and of a pale-yellow colour. The tumour was as large as before in a few days. She was then admitted into the hospital, under the care of Mr. Cock, who punctured the swelling, and the result, as above described, ensued. In May, 1851, she was again admitted into the hospital, under Mr. Hilton. The tumour was rather larger, but no other change had occurred. In June he removed the growth by dissecting it away from the surrounding parts. Most of the serum which the cysts contained escaped at the operation, but it was entirely enucleated. The cicatrization of the wound was tedious and protracted, in consequence of profuse suppuration, but she eventually left the hospital quite well, and the wound healed.

The growth removed consisted of several cysts, composed of a very delicate, loose fibre-tissue, and loosely connected together. They seemed to be in communication with one another, for when I punctured the mass nearly all the fluid escaped, and at the operation, one cyst having been punctured, the size of the mass was greatly diminished.

2. *Cysts on the Spermatic Cord.*—Another region of the body where the serous cyst is developed, and in which part the loose, connective tissue abounds, is around or in front of the spermatic cord. The disease is termed "hydrocele of

the spermatic cord." Cases of this kind are not very common. The tumour varies very much in size, shape, and in its relations to the abdominal rings. When situated near the epididymis it may be regarded as a cyst containing fluid, in which spermatozoa are found. When near the external abdominal ring, and extending through it into the inguinal canal, the tumour assumes some of the characters of an irreducible omental hernia. If firm, resisting, and rather painful when pressed, I have known a swelling of this kind taken for a supernumerary testis.

The diagnostication between a sero-cyst of this kind and a spermatocele is best established by an examination of the contents of the cyst, the fluid in the last being white and more or less milky, whilst in the first it is yellow and clear. From an irreducible omental hernia it may be distinguished by an examination of the *internal* abdominal ring, for although the tumour can be passed through the external abdominal ring into the inguinal canal, a careful scrutiny of the state of the superior opening will prove that the swelling does not enter it; and if the cord, with the cyst, be forcibly pulled towards the scrotum, the normal size of the cord between the internal ring and the tumour will be appreciated—a fact conclusive of the absence of a hernial protrusion.

The formation of cysts in this region may be more easily explained than in the connective tissue of any other part of the body. Extending along the anterior surface of the spermatic cord in foetal life, as well as often for some time afterwards, there is an open canal, lined by a serous membrane. This canal becomes entirely obliterated in the normal condition of the part. Supposing, however, that perfect occlusion is not effected, but that small portions are left in which the serous membrane preserves its integrity, circumscribed spaces would remain, and thus closed, serous sacculi or cysts would exist in front of the cord. These becoming more and more dilated with serum, the morbid growth under description becomes at once established. One or more of such cysts may exist in the same cord. The preparations in the museum, 2369⁵⁰ and 2378, illustrate the relations of these cysts to the cord.

The fluid contents of these cysts resembles the serum from other serous sacs, especially that so often secreted in excess by

the tunica vaginalis testis. It is usually of a pale, straw-yellow colour, clear, or very slightly turbid, and coagulates when heated or on the addition of nitric acid. In some instances the fluid becomes converted into a mass like jelly after standing, or as soon as it has lost its warmth by exposure to the atmosphere. The last condition is, I presume, explicable on the supposition of an admixture of fibrine.

CASE X.—*Cyst on spermatic cord; paracentesis; cure.*

A young gentleman, about nineteen years old, requested my advice concerning a hard, painful swelling on the right side of the scrotum. He said that he felt it come suddenly a few weeks since. I found a hard, tense swelling, seated upon the right spermatic cord, about an inch in diameter, and projecting in high relief. It felt as if there was a bullet rolling about under the skin. The tumour was below the external abdominal ring, and could not be pushed through it into the inguinal canal. The spermatic cord itself was healthy, and of normal size, at and for an inch below the ring and above the swelling. A circumscribed collection of fluid was easily diagnosticated by fluctuation, and through the translucent walls of the cyst. He said it caused great pain on first getting out of bed in the morning for a short time, and which extended down the right leg. The compound tincture of iodine was applied for a few days. No benefit followed this treatment. After that, Emplas. Cantharidis was employed, without affecting the swelling. Paracentesis was then performed, and about one ounce of clear serum, slightly tinged with blood, escaped through a fine canula. This coagulated when heated. The cyst became entirely collapsed, and the serum did not form again.

CASE XI.—*Cyst along spermatic cord; paracentesis; re-formation of fluid; incision; suppuration; cure.*

A rather unhealthy-looking and weak-minded labourer, from forty to forty-five years old, came under my treatment in Guy's Hospital on account of a swelling in the right side of the scrotum. He had been told he was ruptured. With a little care it was readily ascertained that he was not the

subject of a hernia. The spermatic cord, with the exception of that part covered with the swelling, could be freely traced from the internal abdominal ring to the testis. An elongated, ovoid swelling rested on the front of the right spermatic cord. A little pressure sufficed to pass a portion of it through the external abdominal ring, which was larger than usual. A circumscribed collection of fluid was easily diagnosticated from the elasticity, fluctuation, and hardness, perceptible to the finger. The lump had existed several months. It was inconvenient and painful only when pressed. Paracentesis was performed, and about one ounce of serum escaped. It was slightly turbid, pale yellow, and formed a gelatinous mass after a few minutes' rest. The cyst soon filled again. I then cut on to the cyst, which I found much more thick than I expected, allowed the serum to escape, and made an opening an inch long into its lateral wall. A serous membrane lined it. Some lint was introduced; inflammation and suppuration ensued, and the wound healed in a short time. The cyst was entirely obliterated. I attribute the thickness of the sac to wearing a truss.

3. *Entozoa-Cysts*.—The next class of cysts is that which seems to be dependent upon the development of entozoa. I cannot here enter upon the natural history of these parasites, but I refer the reader to the recent works of Küchenmeister and Von Siebold, and published by the Sydenham Society. There are two kinds of these cysts commonly met with in the human subject:

1. That variety which contains a single vesicular hydatid—the *Cysticercus cellulosæ*.

2. That in which several hydatids exist, of different sizes—the *Echinococcus hominis*.

They are not peculiar to any region of the body. They form a tumour of larger or smaller size. Tumours containing the echinococcus generally attain the largest dimensions. Very little inconvenience, and rarely pain, accompanies their development, and their presence does not appear to exert any deleterious influence upon the surrounding tissues. The small tumours formed of the cysticercus are remarkably resisting, and feel quite hard, as if a stone were under the skin. Others, again, have a well-defined, firm ring, in the

centre of which the elasticity of the cyst or the fluctuation of fluid can be detected. The cyst itself consists of the connective tissue of the part, thickened by inflammatory deposit. It contains a little serum, besides the true hydatid. The free surface of the cyst is generally irregular, and covered with granulations. It is not necessary to excise this cyst, a linear incision, sufficiently large to allow the escape of the hydatid, being all that is necessary.

CASE XII.—*Cyst, containing Cysticercus cellulosæ, developed on the thorax; excision; cure.* (Drawing 504⁵⁰, fig. 2.)

A healthy girl, æt. 23, was admitted into Dorcas Ward, in November, 1853, under my care. She came from a country village, situate on the banks of a river. Six months before admission she observed a small swelling immediately beneath the skin, below the left clavicle and upper edge of the left breast. It was about double the size when I saw it. The periphery of the swelling was firm, like a ring of indurated tissue, and surrounded a soft, elastic centre, in which part fluctuation was distinct. The patient complained of a sharp, darting pain when the tumour was pressed, which passed to the shoulder.

I made a vertical incision over the centre of the tumour, and detached it from the subcutaneous fat with a scalpel. It extended no deeper than the layer of fat beneath the integument. This wound soon healed. A section of the substance removed showed a cyst developed in the fat, which contained serum and a single globular entozoon, known by the name of *Cysticercus cellulosæ*. The internal surface of the cyst was covered with minute granulations; the fluid which escaped was not quite clear, but colourless; and the cyst itself seemed to be composed of fibre-tissue and fat, in which the deposits of slow inflammation had taken place. For further information I refer the student to a most interesting account of these parasites in the work by Küchenmeister published by the Sydenham Society.

CASE XIII.—*Cyst, containing Cysticercus cellulosæ, developed in the tongue; removal.*

A woman, æt. 36, was under the care of Mr. Cock, in Dorcas Ward, in March, 1853, who had a hard tumour on the left side of the tongue. It was very hard, and projected

slightly in relief. Mr. Cock made an incision through the integuments of the tongue, and a cysticercus escaped. The wound healed quickly. (Drawing 504⁵⁰, fig. 1.)

CASE XIV.—There is a drawing in the museum of a case of the same kind, which occurred in the hospital under the care of Mr. Hilton. A man, æt. 25, had observed a slight elevation on the upper and under surface of the left side of the tongue, about half an inch from its apex. (Drawing 504⁵⁵.)

In both these cases the observer was struck with the extreme resistance, almost hardness, perceptible when the tumour was compressed between the thumb and finger.

Hydatid cysts of large dimensions, and containing a single large entozoon, or innumerable small ones, to the amount of a quart or more, are sometimes developed in the pelvis, between the rectum and urinary bladder. I have seen a case of this kind, and in the museum are two preparations illustrating the fact (Nos. 2104⁴⁴ and 2104⁵²). In the twenty-ninth volume of the 'Medico-Chirurgical Transactions' two cases are related, one by Mr. Lowdell, another by Mr. Curling. In neither of these cases was the existence of a hydatid cyst suspected during life; but in one I shall immediately relate, a hydatid passed through the catheter which was employed to empty the urinary bladder, believed to be distended with urine. The patient was brought into the hospital, labouring under retention of urine. Means were employed to overcome the impediment, and, after a time, an attempt was made to introduce a catheter into the bladder. This viscus was thought to be distended, as a large, hard mass could be distinguished in the hypogastric region, as well as when the finger was introduced into the rectum. From the position of the catheter, and the depth to which it had been introduced, it was thought it must have reached the bladder. Still no urine flowed. A syringe was next adapted to the end of the catheter, and by exhausting the cylinder, and pressing above the pubes, a small hydatid was brought out. The rarity of such a case, however, prevented the surgeon, the late Mr. Callaway, from attempting further proceedings, and the patient sank, from suppression of urine and exhaustion, in a few days. A like result ensued in the two cases to which allusion has been made.

In cases of this nature, can a surgeon hope to prolong, or perhaps save, life by undertaking any operative proceeding? I believe we may reply in the affirmative. . An examination of the preparations in the museum at Guy's Hospital plainly demonstrates the practicability of reaching the cyst, which, in both cases, was situated between the rectum and bladder and urethra. In the case I saw, the operation of opening the cyst might have been easily accomplished. Post-mortem dissection showed that the catheter had penetrated the membranous portion of the urethra before entering the cyst, and, therefore, if an incision had been made in the median line of the perinæum, and the urethra divided on the catheter or a grooved staff, the operator could not have failed to reach the cyst, and, by making a free incision into its walls, the contents would escape. A correct diagnostication of the disease would be, I believe, attended with much greater difficulty than the treatment of a case of this kind; and I think a surgeon would be justified in making at least an exploration, by puncturing with a trocar or a canular any tumour situated in the pelvis, between the rectum and urinary bladder, and within reach of the index finger introduced at the anus. Now that the fact is established by the observation of four cases, the appearance of a hydatid passing through the canula, or a catheter, would be strong evidence of the existence of a cyst developed around these entozoa, and further proceedings might be undertaken with every probability of success.

The following case is extracted from the reports of the post-mortem examinations made by the late Mr. Wilkinson King. (The twelfth green Inspection Book, p. 87.)

CASE XV.—*Hydatid cyst between bladder and rectum.*
(Prep. 2104⁵².)

James Prentice, æt. 40, by occupation a gardener, much addicted to drinking of spirits, yet, though pale, he was a tolerably stout and muscular subject. He was admitted with an ulcer on the left leg, which showed no disposition to heal. He passed little urine; none could be drawn off with a catheter. He began to labour under the general symptoms of suppression of urine, and as the hypogastrium was distended, it was thought the bladder might still be full; recourse was then had to catheterism, but with no better success, until a

small hydatid was observed to pass. The instrument was again passed, with an exhausting syringe attached to it, and, with the help of this contrivance, a little fluid and some hydatid membranes were evacuated, but none in sufficient quantity to materially alter the size of the abdomen. He sank a few hours after the commencement of the symptoms of suppression of urine.

The abdomen being opened, a tumour was seen, about the size of the uterus in the fifth month of pregnancy. Its coats were in patches of a dead-white, of considerable thickness and resistance. The urinary bladder, of about the ordinary size and thickness, seemed to form a part of the anterior parietes of this tumour, for about four inches above the pubes. It contained no urine, and was only distinguishable by its colour and slight projection from the other parts of the parietes. The left ureter took a circuitous course, and passed transversely across the tumour, near what might be called its fundus; it was thickened and dilated to about the size of one's middle finger, and bore a considerable resemblance to a convolution of small intestine. On laying open this tumour, it was found to contain nearly three pints of hydatids and dead hydatid membranes, intermixed with a dirty-brown fluid and a plastic substance of the same colour. Few of the living hydatids were larger than a good-sized cob-nut, but amongst those which had lost their vitality there were a few that must have been larger than hens' eggs. In the coats of some of these were numerous very minute granules, which caused a slight degree of roughness by their projection on the internal surface. From their size, form, and transparency, they were expected to be nascent hydatids; but on the other hand, their solidity and homogeneous texture, somewhat like that of thick, transparent mucus, were opposed to this idea. In the interior of one or two of the entire hydatids there were a few smaller hydatids, varying in size from that of a mustard to pea seed, adhering by a very tender attachment to the surface of the containing hydatid. In a very few instances, one or two small hydatids were attached to those adherent to the parietes, so as to produce the effect of three beads strung upon a thread; the means of attachment between these little hydatids were extremely slight, and not easily made out. The internal surface of the containing sac was of a brown colour, and rough

and irregular. The thickness of the parietes was irregular, and the texture by no means uniform. When thickest it might amount to one fifth of an inch, of a semi-cartilaginous texture. This cyst was situated beneath the peritoneal coat of the bladder. It likewise extended between this organ and the rectum. The muscular and mucous coats of the bladder were perfectly healthy, so that there was no direct communication between the interior of the bladder and that of the sac. The escape of a few hydatids during life had evidently been occasioned by the catheter having penetrated the sac from the membranous part of the urethra. Both kidneys had their pelves and infundibula, as well as their ureters, considerably dilated; the glandular structure being at the same time reduced, and it appeared to be of a light colour and unhealthy consistence; it was compact, with little appearance of tubuli. The other viscera of abdomen were not disturbed.

Cysts containing *Echinococcus hominis* are developed in the female breast. I have already recorded one case, which was seen at Guy's, in 1846; another occurred in 1856, and a third I find recorded by M. Malgaigne in 1853. ('Revue Méd.-Chir.,' tom. xiv, p. 55.)

CASE XVI.—*Cyst containing Echinococcus hominis in female breast; removal; cure.* (Drawing 410⁶⁰, Prep. 2291.)

A healthy, married woman, æt. 29, applied to Mr. Thomas Callaway, among the out-patients, on account of a tumour in the right breast. She had given birth to four children. Whilst suckling the first-born, six years since, she felt a small, hard spot, about the size of a pea, beneath the skin, over the axillary lobes of the breast. It slowly enlarged, and when admitted into the hospital it measured about four inches across. The tumour was hard, moveable, rolling under the skin, painful when pressed, elastic, and fluctuation of fluid could be detected. Mr. Cooper Forster removed the cyst by a single incision, and the woman left the hospital perfectly well. The disease consisted of a thick cyst, containing fluid, and a great number of delicate, membranous sacculi, in which the entozoa, and especially the peculiar tentacles or hooklets, were distinctly seen.

In M. Malgaigne's case the patient was a married woman,

forty-two years old, and the tumour had existed six years. The cyst and contents were removed by excision, and the patient was cured.

4. The last of this class are *Cysts developed around foreign bodies*.—Usually, the fact of a foreign body having been forcibly driven into some part of the body is known; but, among the working classes, it occasionally happens that, whilst in the pursuit of their employment, the fact escapes observation. In children, also, portions of pins or needles run into the feet, legs, arms, or hands, and after a time a small cyst forms over their cutaneous extremity. As an illustration of the difficulty which sometimes arises in diagnosing a swelling dependent upon the circumstances above alluded to, I will relate the case of a young man who was under my care in the hospital, and which appeared at that time to simulate chronic abscess depending upon some chronic affection of the elbow-joint,

CASE XVII.—A printer, æt. 29, came into the hospital for an affection of the left elbow-joint. He was in tolerably good health, and of a strumous diathesis. For eighteen months he had felt pain and observed a swelling on the outside and a little above the left elbow. To his knowledge, he had never injured the part. Complete extension of the elbow was prevented, and if forcibly attempted, he felt acute pain, which he referred to the articulation. A globular, sub-facial, circumscribed collection of fluid could be felt a little above the external condyle of the humerus, which was somewhat changed in shape and firmness by the movements of the elbow. The joint was kept semi-flexed, and the Ceratum Hydrargyri compositum strapped over the part. He remained in the hospital about six weeks, during which time little local change occurred. His general health, however, rather declining, I sent him home. A short time afterwards the swelling pointed, and with some pus and a slough two small fragments of granite made their escape. The opening soon closed, and the movements of the elbow were perfectly restored.

He did not recollect being wounded in this region, but nine years before, whilst working at a granite wharf, he had frequently been struck with the chips and débris in other parts of the body, which penetrated the cutis and required removal.

Cysts in

Case.	Date.	Sex.	Age when developed.	Description of Progress.	Situation.	Manipular indications.
1	1799	F.	Adult	Left; slow increase; 49 years old when under treatment	Front and side of neck; drawing head to <i>left</i> side	Fluctuation
2	1807	M.	Adult	Right; slow increase for several years; 40 years old when operated on; great trouble arising from its weight	Front and side of neck, from lower jaw to sternum and clavicle	Distinct fluctuation; some enlargement of thyroid gland as well
3	1811	F.	Child-hood	Left; slow increase for several years; 20 years old when under treatment	In front of neck, a little to left side	Fluid contents recognisable
4	1813	M.	13	Left; slow increase for 8 years	In fossa between angle of lower jaw and mastoid process	A scirrhus hardness
5	—	F.	19	Left; increasing for 5 years; large as the head	In front and sides of neck	Relations extensive, spreading over larynx, pharynx, and vertebræ
6	—	M.	Early infancy	Left; increasing until 12th year; as large as a new-born infant's head	Under sterno-mastoid, and extended from the ear to the clavicle	—
7	1830	M.	5	Left; slow increase for 8 years; health good; painless	Beneath the sterno-mastoid; extends from sternal end of clavicle to ear, in front and side trachea, larynx, and œsophagus	Fluctuation, not tense
8	1831	M.	48	Left; no pain or inconvenience; 12 years' growth; progress slow	In front and side of neck, and over clavicle	Distinct fluctuation, not translucent
9	1833	F.	47	Left; 13 years' growth; slow progress	In front and side of neck, and over clavicle	Distinct fluctuation

the Neck.

Nature of contents and cyst.	Local treatment.	Result.	Authority and reference.
Serum, 1½ pint; dark-brown colour; coagulated by heat; second serum less brown	Puncture with trocar; puncture repeated, and injection of red wine (Bordeaux?) with a little alcohol, which was allowed to remain only a few minutes; incision, and seton	Cyst refilled in 24 hours; result of injection, great local inflammation and constitutional disturbance; cured	Maunoir, 'Mém. sur les Amputations, l'Hydrocèle du Cou,' &c., Genève, 1825, p. 98, 1e Obs.
Perfectly limpid fluid, of amber colour, and inodorous, 1 pint	Incised with a bistoury, and seton inserted from above to below	Great constitutional disturbance; cured in a few months	Idem, p. 102, 2e Obs.
A fluid-like infusion of coffee, ½ a pint only withdrawn; next time, dark-brown fluid, coagulable by heat, 2 pounds; third time, 1 pint of brown fluid	Puncture; second time punctured with trocar; punctured third time; puncture repeated four times, and then seton	To empty cyst, which soon refilled both times, the last producing asphyxia; suppuration of sac; cured in about 12 months	Idem, p. 106, 3e Obs.
Fluid quite like water, several ounces	Incision, and excision of sac	Cured; healed by adhesion	Idem, p. 114.
Serum, pale-yellow; rather viscid, but flowing freely; more than 4 pints	Punctured; then incised and stuffed with charpie	After puncture, cyst refilled in 12 days; healed in 19 days	Delpech, 'Chir. Clin.,' t. ii, p. 79, 4to, Paris, 1828.
Serum, yellow; 2 pints	Punctured, incised, and stuffed with charpie	Well in 40 days	Idem, p. 88.
"Light - brownish, watery fluid," a few ounces; cyst, like a serous membrane; several small ones	Incision; insertion of greased lint, removed and renewed	Cured in about 2 months	Lawrence, 'Med.-Chir. Trans.,' 1832, vol. xvii, p. 44.
Reddish serum; no further description; cyst very thin	Puncture with lancet	Wound healed, and fluid again collected	Dr. O'Beirne, 'The Dublin Journal,' vol. vi, p. 10, 1835.
Dark, coffee-coloured fluid; one large cyst, and another smaller	Incision with lancet, and seton introduced	Recovered perfectly in from 3 to 4 months	Idem, p. 12.

Case.	Date.	Sex.	Age when developed.	Description of Progress.	Situation.	Manipular indications.
10	1832	F.	—	Right ; very large, and when under treatment 30 years old	In front of neck, from chin to sternum and clavicle	Obscure fluctuation
11	1836	M.	19	Left ; growing 1 year	Occupied whole side of neck, beneath sterno-mastoid	Fluctuation, and appearance as of three cysts
12	1834	M.	Youth	Right; much increased for a number of years ; is now 30 ; no pain but from distension	Extends from lobe of ear to clavicle, behind the sterno-mastoid	As if composed of solid and fluid parts ; no fluctuation
13	1834	M.	Early adult age	Right ; 4 years' growth ; patient about 30 at time of operation	Occupied whole side of neck, beneath platysma and sterno-mastoid	No fluctuation
14	1837	F.	Infancy	Right ; size of egg	Below the ear, and at side of lower jaw, and side of neck beneath tongue	To be formed of many cysts ; pressure on external tumour made that in mouth increase
15	1838	F.	Congenital	Left ; 1 month old when punctured ; under further treatment at 5 months old	Posterior part of neck, extending under mastoid muscle and carotid, and behind pharynx	Soft, contained fluid, translucent, hard substance at base
16	—	—	Congenital	Right ; growing 8 months ; size of a small orange at its birth ; no pain or inconvenience	Reached from zygoma to cricoid cartilage, and from mastoid process to chin and into floor of mouth	Globular irregularities perceptible, as if cysts with solid and fluid contents
17	—	—	Congenital	Right ; growing 11 weeks ; size of a large orange ; free from pain or tenderness	Reached from zygoma to clavicle, and ear to chin	Soft and elastic
18	1838	F.	14	Right ; slowly developed during 3 years from middle of neck	Side of neck, from ear to sternum	Fluctuation distinct ; thick in front, with two or three solid masses
19	1837	F.	25	Left ; slow growth for 5 years	Side of neck, and behind lower jaw, size of fist, extending from auricle to clavicle	Rather hard, but elastic ; obscure fluctuation ; integuments moveable over it ; a single cyst.

Nature of contents and cyst.	Local treatment.	Result.	Authority and reference.
A greenish fluid, with micaceous pellicles (doubtless laminæ of cholestearine)	Puncture with trocar, and then incision; tent	Inflammation of cyst; cured in about 3 months	Langier, 'Dict. de Méd.,' t. ix, p. 180, 2e edit., Paris, 1835.
Clear serum, 5 ounces from the largest cyst	Puncture and seton	Cured; under treatment 5 months	B. B. Cooper, in 'Guy's Hospital Reports,' 1836, p. 105.
"Glairy fluid, with flocculi;" a single sac, with red eminences on its internal, glossy surface	Excision of entire cyst, but with great difficulty	Cured; healed rapidly	Warren, 'Surgical Observations on Tumours,' p. 543, Boston, 1837.
"Glairy fluid, with white flocculi;" a very simple sac	Excision of entire cyst, but with much difficulty	Cured, and wound healed by adhesion	Idem, p. 550.
Yellow, limpid serosity, 2 spoonfuls	Puncture of external tumour	Death. <i>Necropsy</i> —Multilocular cyst, extending widely and deeply. The walls of cysts thin	Volkus of Lauenbourg, 'Caspar's Wockensch.,' 1837, Nos. 41 and 44.
Serous fluid	Punctured; a second puncture; freely incised, and extirpation attempted	Fluid again formed; cured	J. M. Arnott, in 'Lond. Med. Gaz.,' 1839, p. 917.
"Nearly clear water," with very little trace of mucus or albumen, some mixed with blood	Punctured from time to time; Ung. Potass. Iod. continued for 1 year	Cured	Hawkins, Cæsar, 'Med.-Chir. Trans.,' 1839, vol. xxii, p. 233.
In most cysts transparent, some tinged with blood	—	Death. <i>Post-mortem</i> —Innumerable cysts, extending very deeply between the organs of the region	Idem, p. 236.
Serous, homogeneous fluid, colour of coffee; cholestearine crystal; 1 pint. It coagulated by heat and nitric acid	Incision; again punctured; punctured a third time, and injected with alcohol and water; gum-elastic sound inserted, and injection repeated; iodine	Wound healed, and cyst refilled in a few days; did not inflame after first injection; discharge became sero-purulent in 5 to 6 months	Fleury, in 'Arch. Gén. de Méd.,' 3e série, t. v, 1839, p. 432, Obs. iv.
Homogeneous fluid, like "café au lait," with floating crystal of cholestearine	Vertical incision two inches long; a portion of cyst excised, and cavity filled with charpie	Suppuration established, when patient quitted hospital, with every probability of being cured	Idem, Obs. v, p. 435.

Case.	Date.	Sex.	Age when developed.	Description of Progress.	Situation.	Manipular indications.
20	1836	M.	Adult	Right; growth for many years before the age of 50, when the case was treated	Extending from lower jaw to sternum, and towards left shoulder	A second cyst was found after the first had been opened
21	1838	F.	Adult	Right; growth of a few months. Said to have appeared in one night	Size of an egg, hard and resisting; close to angle of lower jaw	No sign of fluctuation
22	1826	F.	5	Left; slow growth for 26 years. <i>Probably connected with thyroid gland</i>	Side of neck from lower jaw to clavicle	As if composed of a semi-fluid substance
23	—	—	—	Six inches in diameter	Front of neck and chest, between platysma and sternomastoid, and behind clavicle	Thin-walled cyst
24	1858	—	Congenital	Left; 1 month old when operated upon	Behindsterno-mastoid	—
25	—	F.	Infancy	Left; tumour reproduced after Keate's partial removal, and treated by Hewett when patient was 15 years old	In neck, and part dipped behind clavicle, and adhered to subclavian artery	—
26	1858	M.	—	Left; tumour treated when child 3 years old	—	—

Nature of contents and cyst.	Local Treatment.	Result.	Authority and reference.
Clear, lemon-coloured, and inodorous serum, in great quantity	Incised, and sac filled with charpie; a seton through second cyst	Cured	Idem, obs. vi, from 'Annali universali di Med.,' 1838.
Contained a milky fluid, rather thick, in a bilocular cyst	Excision of entire cyst and contents	Cured	Idem, obs. vii, p. 438.
A reddish-brown liquid, in a thick cyst	Attempt to excise the entire cyst	Could not remove the whole, the posterior part being attached to deep vessels; cured	Idem, obs. viii, p. 440.
A clear, brownish fluid	—	—	Thomas Blizard, in Mus. at Roy. Coll. Surgeons, No. 146.
Bloody serum; several ounces	Punctured with fine trocar; afterwards injected with iodine	Well	P. Hewett, 'Brit Med. Journ.,' 1858, p. 446.
At second operation the contents similar to those at first	Excision of a large part of cyst by Keate in infancy; seton introduced by Hewett; diffused suppuration; incision	Deep abscess, and symptoms of purulent infection; cured	Same.
—	Injected with iodine	Cyst refilled afterwards	A. Johnson, in same.

The plate represents the child with the sero-cyst above and below the clavicle. It is described in Case 11.



Wm Hurst 20 4th

Wm Hurst 20 4th

ON
POISONING BY WHITE PRECIPITATE,
BY ALFRED S. TAYLOR;
WITH
THE PHYSIOLOGICAL EFFECTS OF THIS
SUBSTANCE ON ANIMALS,
BY F. W. PAVY.

A FEW years since, it was a contested question whether WHITE PRECIPITATE was or was not to be considered a poison. A trial took place at the Chelmsford Lent Assizes in 1850, at which a woman was indicted for administering this substance to her husband with intent to kill him. She owed her acquittal to the lenient assumption, that there was no evidence to show that white precipitate was either "a poison" or a "destructive thing." Those who have had to consider the general effects produced by mercurial compounds on the body can entertain no doubt on so plain a question as this; but, at the same time, there may be a difficulty in producing cases indicative of its poisonous operation; and, without precedents of this kind, legal minds are disposed to treat all medical opinions as untrustworthy speculations.

White precipitate is a compound containing 79 per cent. of mercury. It is not generally described as a poison by chemists and toxicologists. Orfila, Beck, and most writers on toxicology, pass it over altogether. Dr. Christison merely states that it may probably act as an irritant, but records no

instance of this action. It has been known as a medicinal preparation in the London Pharmacopœia since 1746, but has been employed only for external use in the form of ointment. Very little is known, therefore, of its effects on the human body. I have never seen a case in which it was taken internally, but in my books on Poisons and Medical Jurisprudence I have recorded several cases in which it was taken either by accident or design; and in these, vomiting, purging, as well as pain in the bowels, cramp, and paralysis, were among the symptoms. For this reason I have described it as an irritant poison, but not of a very active kind ('*Med. Jur.*,' 1844). Out of eleven cases which I have collected, in some of which from 30 to 100 grains were taken, there was only one that occurred in 1840, in which this substance is alleged to have proved fatal. It was the case of a child, aged 7, and death is stated to have taken place from salivation, but beyond this there is no account of the symptoms and appearances. In the other ten cases of adults, recovery was probably owing to early and violent vomiting.

As it is usually sold, being only intended for external use, it is often carelessly prepared, and contains corrosive sublimate—a substance from which it is manufactured. I have found as much as from $\frac{1}{2}$ to 3 per cent. of corrosive sublimate in this compound. This is a poisonous impurity, which must render the drug uncertain in its operation. It is stated by the late Dr. Pereira to be largely adulterated with the carbonates of lime and lead, as well as with sulphate of lime. These, however, are not noxious impurities. This author says of it, that "its action on the body is very imperfectly known, no recent experiments having been made with it. It is usually considered to be highly poisonous, and somewhat similar in its operation to perchloride of mercury. Palmarius and Naboth have reported fatal cases of its use."¹

The compound now known in the Pharmacopœia as white precipitate is described under the scientific name of the amido-chloride of mercury ($\text{HgAd}(\text{NH}_2), \text{HgCl}$). There are various theoretical views of its constitution, into which it is here

¹ This statement is quoted from Wibmer's work, '*Wirk. der Arzneim.*,' iii, 64. On referring to Wibmer, it is pretty certain, from the description given, that the effects were produced by corrosive sublimate, contained as impurity in the white precipitate.

unnecessary to enter. Brande represents its centesimal composition to be—

Mercury	.	.	.	79.38
Nitrogen	.	.	.	5.56
Hydrogen	.	.	.	0.79
Chlorine	.	.	.	14.27
				<hr/>
				100.00

This agrees substantially with the composition of this substance as it is given by Pereira. It is procured by adding a slight excess of ammonia to a solution of corrosive sublimate, washing the precipitate with cold water, and drying it by a gentle heat. It is the variable amount of washing which the precipitate undergoes that leads to the retention of a certain quantity of corrosive sublimate in the commercial samples of this compound.¹ This noxious impurity is easily detected by digesting a known weight of the powder in cold ether, and after sufficient agitation, filtering the liquid, and leaving the ethereal solution to spontaneous evaporation. Prismatic crystals of corrosive sublimate are commonly obtained as a residue.

The old White precipitate of the Pharmacopœia, called “Calx hydrargyri alba,” is differently prepared and differently constituted. This is procured by adding (not in excess) a solution of carbonate of potash or soda to a cold aqueous solution of equal parts of corrosive sublimate and sal-ammoniac. It is not decomposed by boiling water, like the preceding compound. It contains only 65 per cent. of mercury, and a larger proportion of chlorine. It is an amido-chloride of the metal, with chloride of ammonium ($\text{HgAd}(\text{NH}_2), \text{HgCl} + \text{NH}_4\text{Cl}$). This compound, to which Pereira refers, as having been discovered by Raymond Lully in the thirteenth century, existed in our Pharmacopœia under the name of Hydrargyrum præcipitatum album, from 1746 until 1836, when the new method of making it was introduced, and it then took the name of Hydrargyri Ammonio-chloridum.

Neither of these compounds appears to have been known to

¹ If the precipitate is washed in a large quantity of cold water, it is apt to undergo a chemical change. If the washing is performed with a small quantity of water, the preparation invariably contains corrosive sublimate.

Boerhaave. In an edition of his 'Chemistry' (1727, Part ii, p. 290) he describes the mode of preparing *white precipitate*, and from this description it is obvious that he intended by it calomel, precipitated by adding a solution of common salt to a solution of nitrate of mercury. He describes the dose internally as from three grains to ten grains, "along with some proper purgative to determine its operation to the intestines; and thus it becomes an excellent cathartic in all venereal complaints, and where phlegm or worms are lodged in the body, as also in the itch or other cutaneous distempers." (Op. cit., p. 290.) In a note, he says—"This medicine is very seldom, if at all, prescribed internally by the *English* physicians, though, if cautiously used, it is safe enough, and has wonderful virtues in the lues venerea and in cutaneous diseases."¹

It is not improbable that the mediæval white precipitate, said to have been discovered by Raymond Lully, was that which is so described by Boerhaave, namely, calomel; and that the compound now in question has a comparatively modern origin.

The *properties* of the amido-chloride of mercury are pretty well known. It is a white chalky-looking solid, very heavy, without any smell. It has a peculiar metallic taste, which is only perceived after a few minutes, and is very persistent. It is insoluble in cold water, but is decomposed by long digestion in it. Boiling water rapidly produces the same change in it; it renders it yellow, and converts it into muriate of ammonia and peroxide of mercury. 1. It is entirely volatile, but when heated is converted into ammonia and calomel. 2. It is soluble in nitric or hydrochloric acid, without effervescence; it is thus distinguished from calomel, which is insoluble in those acids. 3. It is insoluble in ether and alcohol. 4. When heated in the dry state with carbonate of soda, it yields globules of metallic mercury. 5. When boiled in a solution of potash, it gives a precipitate of yellow oxide of mercury. 6. Ammonia produces no change of colour in it (calomel is blackened). 7. It is decomposed by a solution of chloride of

¹ The true amido-chloride is now only used in pharmacy in the preparation of an ointment for external use. This ointment is composed of two drachms of the ammonio-chloride to three ounces of lard; i. e. it forms about one thirteenth part of the weight of the ointment.

tin, a black precipitate of reduced mercury being separated. 8. Boiled with any acid, and treated with gold and zinc, it produces a deposit of mercury on the gold.

With these general remarks, I shall now detail the facts of a recent case of poisoning by this compound, which was referred to me in January 1860, by Mr. Shout, surgeon, and Mr. Blagden, the coroner for Petworth. The medical history of the case will be gathered from the subjoined deposition taken at the first inquiry.

AUGUSTUS CHARLES SHOUT, being sworn, said, I am the medical officer of the Petworth district of the Petworth Union, and attend the workhouse. About three weeks ago my attention was called to the child of Harriet Moore, by Miss Hobbs, the matron. The mother then complained that the child was troubled with wind. The child seemed griped as if from the effects of wind. I prescribed for the child—inquired of the mother as to its diet. I ordered arrowroot to be substituted for bread, and recommended sugar and a little ginger to be added. I also ordered a powder to be given that night, and castor oil to be given in the morning. I do not remember when I next saw the child. I have been at the workhouse almost daily, for some weeks past. There has been much diarrhoea amongst the inmates of the house. I have seen the child from time to time during the last three weeks. The child did not improve at first,—about two or three days after the powder and castor oil had been prescribed. I was at the house one subsequent day, when my attention was again called to the child. I saw it in its mother's arms. I was told the child had been suffering with diarrhoea. I noticed the child's face showed distress. I prescribed diarrhoea mixture for the child. I objected to the food which was given to the child, and I recommended the mother to feed it less frequently. She said she was not satisfied with the way in which the child was going on, and that she should go out and get further advice.

From that time the child improved. It went on very well up to the 20th of December. I saw the child on Monday, the 19th of December. I think it was then down-stairs. I don't recollect anything positive about the child on Monday. I did not see it on Tuesday, the 20th. On Wednesday, 21st of December, about the middle of the day I called at the workhouse. I there saw Harriet Moore and the child; it was lying on a bed. I was surprised at the appearance of the countenance, which denoted most acute pain. A nurse then present said the child kept all the women awake all night with its piercing screams. I felt the child's pulse, which indicated that it was sinking. I touched its stomach, it writhed violently. All the muscles of the face became distorted. I asked the mother what food she had given the child; she said, "I gave it the arrowroot, but it could not swallow." I asked her why; she said, "The throat seems sore." I did not examine the mouth of the child at that time. I told her to give the food in a more liquid state. I did not prescribe anything on that occasion. I noticed the child was remarkably pale, and the hands were cold. I considered the child was dying from a disordered state of its bowels. I considered the best thing to be done for the child was to give it proper food. I did not order any stimulant to

be added to the food, but merely said, they should treat the child as before, only to give the food in a more liquid form. At this time, and up to this period, I entertained no suspicion in this case. I saw nothing in this child different from other children suffering from diarrhoea, except the countenance, the peculiarity of expression, and the contortions of face when I pressed the stomach, which denoted excessive irritation of the bowels, greater than usual from the shortness of the child's last illness, which I considered a sudden attack. The previous illness of the child did not lead me to expect such symptoms. I left the workhouse early in the afternoon; I did not return there that day. The next morning, between 10 and 11 o'clock, I was told at my surgery that the child was dead. I heard nothing more of the child on Wednesday, after I left the house. I did not consider it necessary to see the child again on Wednesday. I thought it was too far gone.

I made a *post-mortem examination* of the body of the child on the 25th of December, 1859. I was assisted by Mr. Morris and Mr. Boxall. The body was well formed, and rather taller than usual for a child of that age. The body was very pale, and slightly emaciated. The countenance was anxious, and indicated great suffering of an acute nature. The eyes were sunken round the orbit. The eyes were unusually glassy in appearance. There was no external mark of violence, no ulceration of the lips. The abdomen was greatly distended; there was no decomposition. There was great redness around the anus, indicating that the excretions were of an acrid nature. The redness extended to the nates, and there were slight excoriations surrounding the outlet. There were no eruptions on the genitals or folds of the groin. We opened the abdomen. There was no increase of fluid; but the small and large intestines were greatly distended, apparently by wind, and presented externally a highly vascular and bright-vermilion-coloured appearance in places, of an arborescent form and of a dry feeling to the finger: in many parts they had lost the usual glistening, slippery character, and towards the right and anterior parts we found unusual signs of vascularity. The small intestines were much tinged with bile in many spots, and bore strong indications of being much inflamed. There was no effusion of lymph or serum discoverable between the convolutions of the intestines. The peritoneum lining the abdomen was not inflamed. The liver was of a natural size, and looked healthy. The gall-bladder was unusually full of bile. The stomach externally appeared natural, with the exception of a small, dark-coloured patch near the lesser curvature. It appeared to be full, and contained a thickish matter; it was tied at both ends and removed. The kidneys were large and apparently healthy. The bladder was quite empty, and appeared healthy externally. As to the thorax, the lungs were inflated, highly vascular, and particularly the lower part of the right lobe of the right lung, which presented a bright vermilion appearance at its inferior margin. There was no adhesion to the ribs; no effusion. The bronchi were examined, and found healthy. The thymus gland was well seen. The heart was of usual size; no fluid in the pericardium, or any sign of disease externally. I then opened the left auricle and ventricle; the auricle was healthy. The mitral valve at its base was highly inflamed, having a vascular, fringe-like border. I then opened the right side of the heart; the tricuspid valve was slightly vascular, presenting the same appearances as the left side of the heart, but not so well marked. There was no clot in the cavities. The parietes were natural. The pericardium contained no fluid. I examined the mouth; there was no ulceration

of that or the fauces. The papillæ of the tongue were much elevated, particularly at the base, but showed no sign of ulceration. I examined the œsophagus; I noticed nothing peculiar at the upper part, but about the middle, the mucous membrane was somewhat congested, and coated with a thick, mucous-looking secretion. The stomach contained about one and a half teaspoonful of a white curdy-looking substance, somewhat thick and gritty, in appearance like lumpy gruel or arrowroot not properly cooked. There was a red patch, of about the size of a three-penny piece, upon the mucous coat of the lesser curvature, about the centre of the curvature, denoting inflammation. There were likewise several other patches of the same character in different parts. The stomach and its contents were placed in a jar, which was sealed up by me; I have possession of it. The duodenum and jejunum were removed; the remainder of the small and large intestines were also removed. I then slit up part of the intestine, from the rectum for about five or six inches upwards. There were no traces of inflammation or ulceration. The part I slit up contained no fluid or fæces; it appeared quite healthy. I then opened the small end of the intestine (the duodenum); there the mucous membrane again was covered with a mucous-looking substance, and appeared slightly congested.

The appearances which presented themselves, upon my opening the body, and which I have mentioned, are most unusual, and, in my opinion, are not attributable to any natural cause. I have no doubt they were produced by some irritant given to the child, which has been absorbed into the system. The appearances I have mentioned are quite sufficient to account for the death of the child. I have not the means of analysing the contents of the stomach. I opened the head of the child; the brain was of full size, and much congested. I sliced the brain and opened the right ventricle; it contained about one drachm and a half of fluid. The left ventricle was natural, and there was about a tablespoonful of fluid at the base of the brain. The congested state of the brain would account for death. When I last saw the child alive it was not suffering from congestion of the brain. When I first prescribed for the child, which was about three weeks prior to its death, I gave it a powder, which contained, by weight, two grains of grey powder and three grains of rhubarb. After an interval of several days, I sent a second powder, precisely similar to the first. After another interval of a few days, I sent a third powder, which contained two grains of grey powder only. I believe I sent a fourth powder, which contained two grains of grey powder and three grains of rhubarb. The last powder I sent for the child, was on the Saturday before its death, December 17th. I ordered castor oil to be given after each powder. Grey powder contains mercury mixed with chalk.¹ The diarrhœa mixture was a twelve-ounce mixture, composed of aromatic confection, two drachms, the same of prepared chalk, half an ounce of gum acacia mucilage, two drachms of paregoric, and filled up with peppermint water. On the first occasion of my prescribing for the child, I touched its stomach; it then showed symptoms of pain, but not to any great extent—not more than usual with children suffering from diarrhœa. I then saw nothing alarming or unusual about the child. On a subsequent occasion, when I saw the child in its mother's arms, and was told the

¹ It appears that during the three weeks of attendance the child had four powders, each containing two grains of grey powder, making eight grains in all.

child was suffering with diarrhoea, a female pauper told me the child's motions were of all manner of colours. I asked if I could see the napkins, and was answered, that they had been washed, or could not be seen. I don't know who gave me that answer. I believe I then gave a direction that a napkin should be kept, that I might see it. Two or three days after that, I saw a napkin. There was nothing unusual in the motion which appeared on that napkin. The matter was coloured yellow and green, contained a little slime, and particles of undigested food. It appeared to me that my medicine had its proper effect. I do not remember that I ordered the child to be placed in a warm bath on the Friday or Saturday previous to its death. I saw the child on one of those days. There was no difference in the symptoms of the child, except that I thought it better at that time. I had no reason to believe the child would die. When I saw the child on Monday, the 19th of December, it was better; it was not at that time suffering from irritation of the bowels. I am positive the inflammation and signs of irritation I found in the body of the child were caused by something given to the child, subsequent to my seeing it on Monday, the 19th. I have no doubt, that if white precipitate, or any irritant of that kind, were given to the child, it would produce the inflammation and unnatural appearances which I found on the post-mortem examination.

The child was three months of age, and brought up by hand. It was admitted into the workhouse on the 17th of November, 1859, and died on Thursday, the 21st of December. It appears from the medical and general evidence, that it suffered, from about the latter end of November until its death, from disordered bowels. There was purging, with occasional pain in the abdomen; the evacuations were green and yellow, and the food was frequently passed in an undigested state. It was sick on Saturday, the 17th of December, on which day it had the last of the grey powders. On Monday and Tuesday following it appeared to have recovered. On the night of Tuesday, the 20th of December, it was much worse; there was great suffering,—had violent vomiting and purging, with difficulty of swallowing. The child from this time sank and died in about forty-three hours from the commencement of this severe attack. It seems that at the time of death there was no suspicion that it had taken place from other than natural causes; but two days after the child's death it was ascertained, that on Tuesday afternoon, shortly before the symptoms became aggravated, the mother, Harriet Moore, had caused to be purchased one pennyworth of white precipitate. She gave a false reason for the purchase: no trace of this powder could be found, and its disappearance could not be accounted for.

The parts of the deceased's body remitted to me for analysis were—1, the liver and gall-bladder with the kidneys, spleen, and the large and small intestines; 2, stomach and contents, with the tongue, fauces, and œsophagus; 3, contents of duodenum and jejunum, in a bottle, marked No. 1 draught; and 4, the heart, with a portion of lung. The result of my analysis, with the conclusions drawn therefrom, are contained in the following deposition given at the inquest.

I subsequently received for analysis two napkins, containing portions of the child's evacuations.

On Tuesday, the 27th of December, 1859, I received from Mr. Kemmish three jars containing the viscera of a deceased child, and a small phial, marked "No. 1, Draught." On the 28th of December I received, from the same person, a brown paper parcel, containing two soiled napkins. I first proceeded to examine the contents of the jars, which were in my custody until I commenced the examination, and they continued in my custody. I found the viscera in a good state of preservation. I first examined the gullet; I found its lining membrane congested at its upper part, and it was covered with a thin mucus, mixed with food; there was no inflammation or ulceration about these parts, and the windpipe was in a healthy condition; the stomach had been opened; on re-opening it I found, at the greater end, a curdy, whitish-brown substance, of the consistency of thick paste; there was about as much as would fill a large tablespoon, and upon this there was a thin and dark coagulum of blood. I found this pasty matter closely adhering to the coats of the stomach, and mixed with much mucus. On removing it, the greater part of the lining membrane of the stomach appeared pale, except towards the intestinal opening, where there was a small red patch, arising from congestion of the vessels. The intestines were, generally speaking, empty; in some parts of the small intestines I found a small quantity of pasty-looking substance, coloured by bile; the large intestines contained no fæcal matter. On laying open the intestines I found the duodenum and jejunum highly inflamed, and the vessels strongly injected with bright-red blood. The inflammation was in the mucous or lining membrane chiefly; there were some patches of inflammation in the lower part of the small intestines. The large intestines were but slightly affected. The liver, kidneys, heart, and lungs presented no appearance of disease. In one kidney I found two small calculi. There was nothing about these last-mentioned organs to account for death. I examined the different parts chemically, beginning at the upper part. I first examined the congested part of the gullet, with some of the pasty matter adhering to it: I found it to contain a small quantity of a mercurial compound, and with this was some starchy matter. I next examined the stomach: the thick pasty contents of the stomach were removed, and mixed with about two ounces of distilled water; the liquid was of a brownish-white colour, not mixed with blood or bile; it contained a number of heavy chalky-looking particles, which rapidly subsided when mixed with water; they did not dissolve in water; they had the appearance of mineral matter. I examined the

contents microscopically and chemically : I found the greater part consisted of starchy matter, like gruel, with digested food, mucus ; and with these there was an *insoluble compound of mercury*, which had all the properties of white precipitate. I then examined the coats of the stomach, having scraped away all the contents, and I found a small quantity of mercury in them. I next examined the contents of a bottle I received from Kemmish ; it was marked, "The contents of the duodenum and jejunum ;" it contained a bilious-looking fluid, with mucus. I did not find in it any of the white particles I had seen in the stomach, and there was neither starch nor any mercurial compound in it ; it was merely a mixture of mucus and bile. The coats of the upper part of the small intestines were analysed, and found to contain a small quantity of mercury. In the ileum, about three inches of the bowel were distended with a pasty-looking substance, resembling that found in the stomach. I found, on examining it, that it contained a starchy substance, mixed with a mercurial compound. I could not detect in it any of the white particles, such as I had seen in the stomach. The large intestines were empty. The coats of the colon or large intestine, were found to contain mercury.

I next examined the napkin. It was stained with faecal matter, of a green colour. I cut out a portion of the stained part of the napkin ; it contained a quantity of mucus, dried upon the cloth, altered bile, which gave to it its green colour,—a quantity of starchy matter, and a comparatively large quantity of a mercurial compound, that is to say, more than I had found in the bowels. There was no blood. I examined an unstained portion of the napkin : I found in that, starch without mercury or mucus.¹ I examined one half of the heart ; it contained no mercury. I examined one fifth part of the liver, and found mercury in it. I afterwards examined one of the kidneys, and separated mercury from it. The twelfth and last analysis related to a sample of white precipitate, which I had received by a registered letter through the Post Office, from Charles Whitcomb ; it had all the usual chemical characters of white precipitate, with the addition of starch. It contained a small quantity of corrosive sublimate. I weighed out twenty grains of this white precipitate, and, on analysis, found it to contain one tenth of a grain of corrosive sublimate. In the powder which I received from Mr. Whitcomb there were fifteen grains of white precipitate and five grains of starch, or thereabouts. It was fully one fourth starch.²

From this examination and analysis I have drawn these conclusions :

1st, A mercurial compound, which I believe to be white precipitate, mixed with farinaceous and other matters, was found in the contents of the stomach.

2d, That a mercurial compound, mixed with starchy matter and mucus, was found in the discharges on a napkin.

¹ The second napkin was not examined until the 15th of March. The evacuation upon it contained mercury. There were many more napkins used, but only these two could be procured, and one was not distinctly traced to the prisoner.

² The white precipitate powder here referred to, was from the same stock as that supplied to the prisoner. Whitcomb sold about a drachm for one penny. It was not weighed. It was mixed with starch before delivery. The packet was distinctly labelled, in printed letters, "Poison," and it was proved that the prisoner could read. It was asked for and sold as "white cipity powder."

3d, That a mercurial compound, with starch, was found in the middle portion of the gullet and in the lower portion of the small intestines, and that mercury, without starch, was found in various parts of the small and large intestines, as well as in the liver and one of the kidneys.

4th, That the appearances presented by the viscera were—redness in the gullet, a patch of redness in the stomach, great redness (with injection) of the vessels at the upper part of the small intestines, less in the large intestines; the redness was of an inflammatory nature—what is called acute inflammation; it was seated in the mucous or lining membrane, and it was such as might have been produced either by the action of an irritant substance, or as the result of disease.

5th, The heart, liver, lungs, kidneys, and spleen presented no appearance of disease, and no appearance to account for death.

Examined.—The mercurial compound I found in the stomach could not have been grey powder, calomel, or corrosive sublimate. I found it in the stomach in an insoluble state. White precipitate is insoluble in water; it is, to some extent, soluble in the acid juices of the stomach.

If I had been told to examine a body which had been poisoned by white precipitate, I should have expected to find an inflammatory redness of the stomach and intestines. I found, as I have said, what I believe to be white precipitate. I was surprised, in this case, to find so little redness of the mucous membrane of the stomach. As far as I can judge from what I found and what I saw, the child died from inflammation of the bowels. The quantity of precipitate found in the body of the child was small. One of the effects of white precipitate would be to produce vomiting and purging. When there is a loss of power of expulsion of the matter by vomiting and purging, it might, by remaining in the body, produce inflammation. It would act as an irritant; it contains 79 per cent. of mercury. In thirty years' experience I have only been professionally consulted in one case; in that case the man recovered; he took about twenty-five grains. I delivered a portion of the contents of the jars to Dr. Miller, of King's College.

Analysis.—It will be proper to describe in this place the process of analysis pursued. 1. *Stomach and contents*—By simply washing them in successive quantities of distilled water, a number of heavy, white particles, of a slightly yellowish tint, were separated. A portion of these admitted of drying and weighing. There was much starch intermixed with them. These white particles gave no soluble compound of mercury to boiling water. They were readily soluble in acids, even in the acetic, without effervescence, and the acid liquid deposited mercury on a clean surface of copper, and on gold-foil invested with a spiral of zinc-foil. It gave the usual black precipitate indicative of mercury, when the chloride of tin was added to the solution. When some of the white particles were triturated with chloride of tin, they underwent a similar change; but when treated with ammonia, they remained white. A

portion of the food containing some of the white particles, when boiled with a solution of potash, evolved ammonia; but as there was much animal matter in the liquid, no positive conclusion could be drawn from this result. Again, a portion of the contents, acidulated with nitric acid, gave an abundant deposit of chloride of silver when nitrate of silver was added to it; but as chlorides are found in the contents of every stomach, this result also was inconclusive. From a portion of gold-foil whitened by the compound, a number of globules of mercury were obtained by sublimation in a reduction-tube. The food found in the stomach, therefore, contained an insoluble compound of mercury, having the characters of white precipitate. No grey or red compound, no chalk, and no globules of metallic mercury were contained in the washed sediment of the contents. The contents of the intestines, and the matter on the napkins, were analysed by similar processes. The evidence, however, fell short of that yielded by the contents of the stomach, inasmuch as no white particles could be obtained from these articles by washing.

Tissues.—The process for the detection of mercury in the liver and kidneys was as follows: 1. The organ was sliced into small pieces. 2. The sliced portions were gently heated in a mixture consisting of two measures of hydrochloric acid and one measure of water, until the structure of the organ was entirely broken up and dissolved. (A portion of the liver was distilled with hydrochloric acid, but no arsenic or antimony was found in the acid contents of the distillate.) 3. The acid decoction was diluted with four parts of water, and a small galvanic coil of gold and zinc was plunged into it while boiling. (This coil consisted of a strip of gold-foil, one inch long by one eighth of an inch wide; it was twisted spirally *on the outside* of a piece of zinc-foil, of somewhat larger dimensions.) The gold was speedily whitened in all the experiments, while the zinc was in great part dissolved. The whitened gold was removed and well washed in water; it was dried and divided into two parts. One half, heated in a reduction-tube, gave a splendid ring of mercurial globules, having a silvery lustre by reflected light, and appearing as black, opaque spheres by transmitted light. The other half was warmed in two or three drops of strong and pure nitric acid. The white deposit was

speedily removed, and the gold reacquired its colour. The acid liquid was poured off, diluted with water; a few drops of chloride of tin were added, and the liquid was warmed. A fine, greyish-black precipitate of metallic mercury subsided. The gold and zinc, as well as the nitric and hydrochloric acids, were tested for mercury, and were found free from this metal.

Although mercury was precipitated on the gold from the *cold* acid decoction of the liver, yet it was found to take place very slowly and imperfectly; and I believe that, when the quantity of mercury is very minute, boiling is a necessary step in the process, if we wish to ensure complete precipitation.

Copper-gauze, free from mercury, was also employed. The boiling acid decoction of the liver silvered several small pieces of gauze, and from one of them, after washing in alcohol, a well-marked ring of globules of mercury was obtained by heat.

These results proved that mercury was present in some of the soft organs, probably in the metallic state, or in an organo-metallic combination.

After these experiments had been performed, I requested the authorities to allow Dr. Miller, of King's College, to make an analysis, in his own laboratory, of one half of the various solids and liquids sent to me. These were placed in his hands, without any information having been communicated to him of the results obtained by me. The questions submitted to him, were—1. Is any mercurial compound contained in the viscera or contents? 2. If so, what is its nature, and what the proportion in which it probably exists.

Dr. Miller reported that he found mercury in an insoluble form, distinctly, in the contents of the ileum, in the coats of the stomach, in the substance of the liver, and in the intestines generally. It was present in considerable quantity in the matter upon the napkin. There was no mercury present in the substance of the heart, or in the bilious contents of the duodenum and jejunum. Dr. Miller's conclusions were—1st, that a preparation containing mercury is present in the stomach and contents; 2d, that this preparation is not a soluble one; and 3d, that it is neither calomel, grey powder, nor red oxide of mercury, but that it presents all the characters of white precipitate.

These conclusion substantially confirmed those which I had previously drawn from my experiments. From a comparison of our results, and an examination of the white mineral sediment obtained by washing the contents of the stomach, we estimated that the amount of the mercurial compound present in the parts examined was from three to five grains ; the greater part being contained in the evacuation on the napkin. The stomach contained more than the intestines.

The chemical results might have been disturbed by the fact, that during the three weeks' illness, the deceased child had taken, at intervals, eight grains of grey powder. As this compound contains three eighths of its weight of metal, the child had taken altogether three grains of mercury. We satisfied ourselves, both by affirmative and negative experiments, that the mercury in the stomach was not in the condition of grey powder, but of a white insoluble compound. The state of the mercury in the intestines and on the matter of the napkin could not be proved by any direct experiment ; still there was a strong presumption that it was of the same nature as that found in the stomach. No calomel, or any other preparation of mercury, had been given. The mercury found in the liver and kidneys had been deposited by absorption during life, but whether this was owing to the grey powder given medicinally, or to the white precipitate assumed to have been given by the mother on Tuesday night, we could not say. Either view was reconcileable with the discovery of mercury in these organs.

Although the cause of death was, medically speaking, left somewhat doubtful by reason of the previous illness of the child, the jury, upon the evidence, returned a verdict of " Wilful murder " against Harriet Moore, the mother, and she was committed for trial at the Assizes.

As some doubt subsequently arose, whether the medical evidence clearly assigned a cause of death, and was sufficient to support a charge of murder, a series of questions was submitted to me, the nature of which will be understood from the subjoined remarks :

1. Apart from the alleged administration of white precipitate to the child, the screams heard on the night of the 20th (a few hours after the supposed administration of the poison) might be ascribed to severe pain, occasioned by inflammation

of the stomach and bowels, under which the child was then labouring, either as an effect of poison or of disease. The sinking state observed on the following day (Wednesday) might be the result of exhaustion from a severe attack of inflammation of the bowels, whether resulting from disease or poison.

2. There was nothing in the condition or appearance of the inflamed parts to show whether this inflammation depended on natural causes or on irritant poison. But for the finding of white precipitate, there would have been no reason for attributing it to the action of irritant poison.

3. The child had been more or less affected with purging, and other symptoms of disease of the bowels, up to Saturday, the 17th, *i. e.* three days before the fatal symptoms set in.

4. The child had apparently recovered, and was well on the Monday and Tuesday before the attack came on in the evening. Whether this sudden attack of inflammation was or was not likely to be a sequence of the illness under which the child had previously laboured, must mainly depend on the opinion formed by the medical gentleman in attendance. If he treated the last illness only as a relapse, and the death as not an unusual consequence (until something had been said about white precipitate), then this would go far to show that, in his view, the inflammation might have arisen from natural causes. Infants of this age are liable to sudden attacks of inflammatory diarrhœa and gastro-enteritis.

5. I am not aware that any particular condition of the brain has accompanied a fatal attack of inflammatory diarrhœa or gastro-enteritis in children. The brain of an infant is generally found more congested than that of an adult. Slight disturbing causes increase this congestion, and thus give rise to insensibility or convulsions. Hence the life of an infant under an attack of infantile diarrhœa is often cut short by disturbance of the brain and nervous system; death being preceded by convulsions and stupor.

6. Taking the fact that white precipitate, or a preparation of mercury, was found in the gullet, stomach, and bowels of the child, and in matter voided on a napkin,—with the sudden occurrence of pain, vomiting, and purging, on Tuesday evening,—the sinking state or collapse on Wednesday, and

death on the Thursday morning, with the discovery of an inflamed state of the bowels and stomach, it appears highly probable that white precipitate was the direct cause of the inflammation and death.

7. White precipitate is a mercurial poison. Its action, so far as it is known, is to produce vomiting of a violent kind, purging, and collapse. The appearances likely to be found in the body are those of inflammation and ulceration. If the poison is thrown off by vomiting, the person may recover; otherwise, death takes place. Here the poison had been in great part thrown off. The quantity remaining in the body was small, but the infant was exhausted by the effects produced.

8. A rabbit died in a few hours from a dose of five grains; another also, in an equally short period, from four grains. Rabbits do not vomit. The white precipitate used in these experiments was taken from the same sample as that which was supplied to the prisoner.

9. The medical difficulty that arises in this case, in assigning death absolutely to white precipitate, is—1. That there was no specific symptom, such as *salivation*, to point to the effect of a mercurial irritant compound. 2. That only one fatal case in a human being is recorded of death from this poison, and in that case, the child had salivation, and it apparently died from the effects. 3. That with the exception of some experiments on animals, there is no medical experience of the effects of this poison on the body. 4. That the quantity of the precipitate found in the body of the child was not what could be called a fatal dose.¹ 5. That, evidence of the presence of

¹ The quantity of poison found in a dead body forms no criterion of the quantity administered or taken. It depends on the amount of vomiting and purging, and other circumstances. The actual dose taken in this case was a matter of doubt. The druggist stated that he sold one drachm for a penny: commonly, only a scruple is sold for this sum. Allowing that there were sixty grains, and deducting the starch mixed with it, there would have been forty-three grains of white precipitate. As twenty grains of the mixed powder contained one tenth of a grain of corrosive sublimate, so the deceased, if the whole sixty grains were given, must have taken three tenths of a grain of corrosive sublimate. This, in itself, is a large dose of a powerful poison for a child. The quantity of mercury found, estimated as white precipitate, did not exceed five grains, of which the greater part was on a napkin. If forty-three grains were given, thirty-eight grains were no longer forthcoming. There is nothing surprising in this. None of

absorbed poison, deposited in the liver and other organs, utterly fails in this case, because a compound of mercury (grey powder) had been given during the treatment, and it is impossible to say whether the mercury extracted from the liver and other organs, depended on the white precipitate taken shortly before death, or on grey powder, (mercury and chalk) given some days before death. 6. That, putting aside the white precipitate found in the body, there is nothing in the appearances which I saw irreconcilable with the effects of disease.

From these considerations, it is difficult to say that white precipitate, if administered on Tuesday, was the direct and only cause of the inflammation of the bowels. Had the child not been ill with disordered bowels, and other symptoms of disease, for a period of three weeks preceding death, a stronger opinion might have been expressed. As it is, the cause of death is so doubtful, that it admits of the expression of no positive opinion; and although the medical "facts are full of suspicion," there is "not absolute and complete evidence" that this infant died from the effects of white precipitate.

It may be regarded, from recent events, as hopeless to attempt to convict any one of the act of poisoning on a charge of murder, unless—1, Every step is susceptible of the clearest proof by eye-witnesses; 2, unless there is an entire absence of disease; and 3, unless there are such special characters about the symptoms and appearances in the body, that no medical doubt could for a moment exist among two or more medical men, touching the inference to be drawn. In this case, there is proof of purchase and possession of the means of death—there is said to be sufficient motive—the substance purchased is found in the dead body, and by a reasonable medical inference, it might have caused the symptoms and appearances found in the body; but against these facts we must set the previously diseased and unhealthy condition of the vomited matter was procurable, and most of the evacuations had been thrown away, as no suspicion of poisoning then existed. There was not enough remaining in the body to kill another child, yet still this child might have died from the effects. It is a remarkable fact that, with these well-known reasons for the disappearance of poison from the body, juries are so frequently directed, that a fatal dose must be found in the body, or the chemical evidence is to be regarded as incomplete.

the child, and the effect likely to be produced on an infant of three months by improper food and general neglect.

The result of this examination of the evidence was, that at the Assizes the charge of murder was abandoned, and the prisoner was indicted upon the charge of administering poison with intent to murder.

The trial took place at the Lewes Lent Assizes, 1860. Dr. Miller, Dr. Pavy, and myself attended, and gave evidence for the prosecution. The facts, as above detailed, were proved to the satisfaction of the Court, and the prisoner was convicted of the charge.

The following is a summary of our evidence at the trial :

Alfred Swaine Taylor deposed—White precipitate is an insoluble compound of mercury. It is an irritant poison. On the 27th of December I received from Kemmish some jars, and on the 28th some napkins. I examined the gullet, and found the lining membrane congested, and covered with a thin, pasty substance, mixed with mucus. There was no acute inflammation, neither was there any on the windpipe or parts connected with the throat. I scraped off a portion of the mucus and pasty matter from the gullet, and I found in it a small quantity of mercury, and the pasty matter was partly starch. It was an insoluble compound of mercury. I examined the stomach. It was distended, and on laying it open I found it contained about a teaspoonful of pap, such as is given to children. There was a small red patch on the mucous membrane. I analysed the pasty matter I found in the stomach. I found a quantity of white, chalky-looking matter. It had the property of white precipitate powder, and I have no doubt it was white precipitate, which is an insoluble compound of mercury. I proceeded to examine the intestines, which showed, in parts, acute inflammation. The small intestines were nearly empty, except at the lower part. I found in the contents of the lower bowels an insoluble mercurial compound, but cannot say it was precipitate. There are three common insoluble compounds of mercury—grey powder, calomel, and white precipitate,—the only one resembling precipitate being calomel. Grey powder would not account for what I saw and found. I found no chalk, which forms nearly two thirds of grey powder. Grey powder would not cause the inflammation. If the mercury had been administered in the form of grey powder, I should have expected to find chalk. In the large intestines I found patches of redness. There were traces of mercury in the liver. I found in one kidney traces of mercury, the result of absorption. These organs were perfectly natural. The child died from inflammation of the bowels. White precipitate would cause inflammation of the bowels. The action of it on the bowels would occasion great pain. It would also produce vomiting of the most violent kind, and purging. The vomiting would take place, if the stomach were empty, shortly after it was administered. I examined one of the napkins at the time I received it. I found, in the matter upon it, a large quantity of a mercurial compound, mixed with bile and starch. On the other napkin, which I examined recently, I

also found traces of mercury. The heart was the only organ I examined which contained no mercury. I examined the specimen of white precipitate sent in a letter by the chemist. There were 82 grains of powder, containing 28 per cent. of starch, and 72 per cent. of white precipitate. In a drachm of the powder I received there would be about 43 grains of precipitate. If the child had had the whole of the powder administered to it on Tuesday, it would account for the appearances found in the bowels. The time it survived would be affected by the strength of the child. I cannot account for the presence of white precipitate in the body, except on the assumption that the child had swallowed it.

Cross-examined—If 43 grains of the precipitate had been administered on the Tuesday night, there is nothing improbable in the child surviving until Thursday. It would become exhausted from the continual vomiting and retching. It is possible that in one act of vomiting a large proportion of the powder might have been thrown off. The stomach was the only organ in which the white precipitate was detected. If the child survived, it would only be by the powder passing off as a result of natural evacuation. The quantity of mercury in the liver was small, as absorbed poison is always found. My experiments do not enable me to say that 40 grains must have been administered. I should imagine a few grains would produce the appearances I witnessed.

Dr. William Allen Miller deposed—On Tuesday, February the 3d, I received certain parts of the body from Dr. Taylor. I was told to ascertain if there was any mercurial compound present, and if so, what was the nature of it. I found in the contents of the stomach a quantity of farinaceous food, mixed with mucus. I found white precipitate with it. I afterwards examined the stomach, and found that the coats contained mercury. I examined a bottle containing a liquid from the ileum, which contained mercury. I examined the liver, and found mercury deposited in it. I also found mercury in the matter on the napkin. In the two articles in which Dr. Taylor found no mercury I did not, but did so in all the rest.

Dr. Frederick William Pavy, of Guy's Hospital, said that the evidence given was quite consistent with the experiments he had made with white precipitate on animals. White precipitate is one of the most irritant poisons he knew of, and it acted directly on the surface with which it came in contact. Grey powder, in moderate doses, would not account for the appearances.

Cross-examined—I agree with Dr. Taylor when he says that a few grains of white precipitate would cause excessive vomiting. I should say two grains would cause vomiting and inflammation, and might produce the effects which Dr. Taylor has described. Inflammation from so small a quantity might produce death in so small a child. I think it not improbable that if the dose of white precipitate was given on Tuesday night, the child might live till Thursday at two o'clock. I administered a large dose of precipitate to a dog, and it survived four days. The dog is more closely approximated to a human being than any other animal as regards the action of poison.

Cases of Poisoning by White Precipitate in the Human Subject.

It is unnecessary to give the details of these cases with the exception of two of the most recent, for a report of which I am indebted to Mr. Boxall. Taking them chronologically—

No. 1. 1840.—The case of a female, admitted into St. Thomas's Hospital; dose taken unknown. *Recovery.*

No. 2. 1840.—The case of a child, æt. 7 years, recorded in the 'Returns of the Registrar-General' for that year. The child died from profuse salivation. *Death.*

No. 3. 1849.—The case of a female adult; she suffered from violent sickness and paralysis of the limbs. This case gave rise to a trial at the Exeter Lent Assizes ('Regina v. Evans'). An acquittal took place for want of sufficient evidence. *Recovery.*

No. 4. 1850.—In this case a woman administered to her husband white precipitate, on meat. About 25 grains were taken. It led to violent vomiting, which lasted two hours, during which the poison appears to have been expelled. The woman was tried for the administration of poison, at the Chelmsford Assizes, but acquitted, as it was considered that white precipitate was no more poisonous than blue pill or grey powder. *Recovery.*

No. 5. 1850.—A case which occurred to Dr. Bence Jones, in St. George's Hospital, and is reported by him. A girl, æt. 18, took 40 grains of white precipitate. She said that it tasted like chalk. In half an hour she had severe pain in the stomach, followed by retching and violent vomiting. She remained two days under treatment. *Recovery.*

No. 6. 1855.—This case, that of an adult man, who suffered from violent vomiting, was the subject of a trial for administering poison, at the Bristol Assizes. The prisoner was convicted. *Recovery.*

No. 7. 1857.—A case which occurred to Mr. Scott, of Stafford. No particulars. *Recovery.*

No. 8. 1857.—A case which occurred to Mr. Walker. A child, æt. 2 years, took 40 grains. On the following day *recovery.*

No. 9. 1857.—A case communicated to me by Mr. Procter, of York. A dose of 40 grains was taken by a woman. In half an hour she complained of pain in the gullet, extending to the stomach, and her mouth was dry and clammy. It is remarkable that there was neither vomiting nor purging until a dose of tartar emetic and castor oil had been given. In three days *recovery*.

No. 10. 1857.—A case which occurred to Mr. Michael, of Swansea. A woman, æt. 37, took 100 grains. She suffered from pain in the stomach, with cramps. There was violent vomiting, for two hours, of a thick, white mucus, which deposited a white sediment. There was also purging. There was great prostration, and the pain in the stomach did not subside for several days. *Recovery*.

No. 11. 1857.—A case which occurred to Mr. Giles. A girl took 30 grains; she suffered from much pain in the stomach, and there was frequent purging. On the following day there was swelling of the face and gums, with salivation, which lasted several days. *Recovery*.

I subjoin the two recent cases communicated to me by Mr. Boxall :

No. 12. 1858.—A woman, æt. 23, four or five months pregnant, was admitted into the Great Northern Hospital, under the care of Dr. Coote, on January 30th, 1858. She had swallowed a halfpennyworth (from 15 to 20 grains) of white precipitate, in powder, at 6 p.m. The first symptom which she observed was, as she described it, a horrible taste. It occurred immediately, and was followed by a burning pain in the throat and stomach. She was, however, able to walk for a quarter of an hour, without attracting attention. She then sucked an orange, and this was followed by vomiting. About half an hour, therefore, had elapsed without any urgent symptom presenting itself. As she was passing the hospital she complained of dimness of sight, and she nearly fell down; this induced her to apply for aid. Faintness, and not pain, was the chief symptom at this time. The stomach-pump was applied, and oil was injected. Castor oil was also given to her. January 31st.—There was much pain in the throat and stomach, with difficulty of swallowing; the tongue felt swollen. There was pain in the gums of the lower jaw. February 1st.—She

was slightly salivated, and the tongue was covered with a thin, white fur. February 2d.—The gums were rather swollen and spongy. There was a *blue line* around the edges of the gums. The bowels were not open, and there had been no purging. There was less pain in the throat and stomach, and the act of swallowing was less painful. There was great tenderness over the region of the stomach. She gradually improved until the 6th, when she had recovered from the effects of the poison. Abortion did not follow.

No. 13. 1860.—A. S—, a girl, æt. 18, was admitted by Mr. Clapton into St. Thomas's Hospital on February 5th, 1860. She had taken one pennyworth (30 grains) of white precipitate thirteen hours before admission. This had caused vomiting. She now complained of pain in the throat, extending to the stomach. Castor oil and eggs were prescribed, with barley-water. This girl recovered in a few days. The account she gave to Mr. Boxall was, that she swallowed the poison in a cup of cold water, at 11 o'clock a.m., on Sunday, February 5th. She rinsed the vessel out with some more cold water. She had the intention to destroy herself. In a quarter of an hour after taking the poison she felt giddiness. She lay down and lost herself completely. Some salt in water was given to her, and this made her very sick in five minutes. She suffered from severe pain in the stomach, was purged all day, and was taken to the hospital at 12 o'clock at night. The pain in the stomach and purging continued during the four days she remained in the hospital. There was great thirst, but no difficulty in swallowing. There was no soreness of the gums, nor salivation, in this case. The quantity of white precipitate taken was 30 grains. A sample of this precipitate was brought to me by Mr. Boxall. It contained no starch, nor any impurity, excepting corrosive sublimate, of which it contained about 1 per cent.

Effects of White Precipitate on Animals.

To aid this inquiry, and to supply that post-mortem and chemical evidence which, from the paucity of fatal cases among human beings, appeared to be absolutely necessary, I called in the aid of Dr. Pavy. Experiments were performed by him

with some of the white precipitate procured from the druggist's stock at Petworth (being the same as that supplied to the prisoner), and also with other specimens procured from respectable druggists. As a general rule, the white precipitate before use was deprived of any corrosive sublimate by digesting it in ether. I may here remark of four samples submitted to examination, that corrosive sublimate was contained in all.

The subjoined remarks on the effects of this substance are by Dr. Pavy.

Physiological action of White Precipitate.

The action of white precipitate on animals is that of a powerfully and purely irritant poison. It has proved fatal to the dog, rabbit, and mouse, on which animals its effects have been tried. The symptoms widely differ in the dog and rabbit, on account of the one being an animal that is most susceptible of vomiting, the other an animal that never vomits.

EXPERIMENT 1.—In the case of the dog, *twenty grains* of white precipitate mixed with the food were devoured without the slightest reluctance on the part of the animal, there being no sign of discovery of the presence of the poison. In a quarter of an hour, violent vomiting was produced, and in two hours the whole of its food with the white precipitate, had been rejected, and the animal seemed to have recovered. It drank water, but refused to touch food again. A few hours later, *twenty grains* more of white precipitate were mixed with some mucilage and injected through a gum-elastic tube into the stomach. Within five minutes most violent vomiting was induced, which lasted about two hours, when the animal appeared to have ejected the poison, and to have recovered. At first a white mucus was brought up, but afterwards mucus streaked with blood. On the following day *ten grains* were administered in two portions, at an interval of three hours. Upon each occasion the same violent vomiting was almost instantly induced, and the mucus that was ejected was streaked with blood. Although no more white precipitate was given, yet the animal refused to eat, grew gradually more feeble, and died five days after the commencement of the observation.

On making a post-mortem examination, the stomach was found to contain a small quantity of a dark-green, viscid fluid, apparently a mixture of bile and blood. The inner surface of the stomach was strewed over with small patches of ulceration. The small intestine was injected a little at its two extremities, but appeared otherwise natural. The cæcum and large intestine also were unnaturally injected, and the glands were prominent and dark-coloured, but there was no sign of ulceration.

It is thus evident that white precipitate acts as a violently acrid poison when introduced into the stomach. Its effects here were directly and only, to any significant extent, on the stomach ; and, probably, this was the only organ upon which the poison could act, vomiting occurring after each administration, until apparently the whole of it was rejected. The vomiting was of an exceedingly violent character, showing how strongly the surface of the stomach must have been affected. By the repeated administrations that were resorted to, fatal gastritis was induced.

On the rabbit the effect of a dose of four and five grains is to kill in the course of a few hours. In one instance *five*, and in another *four*, grains were administered to a full-sized rabbit at half-past five in the evening, by means of injection into the stomach, mixed with a little water, through a gum-elastic catheter passed down the oesophagus. In each case the rabbit was found dead, cold, and rigid, on the following morning. On examination, the lungs and pleura were found natural. The heart was gorged with dark-coloured blood on both sides. The interior of the stomach presented intense redness in patches, and a few dark-coloured spots, looking as if blood had been extravasated on the surface. Attached to a large portion of its extent was a white, false-membrane-like layer, which was so firmly adherent that it resisted the action of water in removing it, but could be peeled off in strips with the knife. In this false-membrane-like layer a few opaquely white particles were discoverable, which bore the aspect of white precipitate. Towards the pyloric end of the stomach there was a clear, gelatinous material separating the viscus from the food. The intestinal canal, except at its upper part, looking here and there a little preternaturally vascular, presented an ordinary appearance throughout.

In smaller doses the administration of white precipitate may be persisted in for several days, but it ultimately kills from the effects of inflammation of the alimentary tract, and there is at the same time a most peculiar condition of the kidney produced. Even in two-grain doses *per diem*, at first the rabbit manifests no symptoms of disturbance, eating its food and appearing lively; but afterwards diarrhoea sets in, the animal refuses to eat, and looks dull and pinched-up. In one case *two grains* a day were given for seven days without producing any perceptible effect. *Two grains* twice a day were then given, which the animal supported for three days. On the following day the rabbit had died before any injection was practised. The day after the quantity was increased, the animal showed signs of disturbance, and then grew rapidly worse. It took *twenty-six grains* in all before death was produced. In another instance one grain was administered the first day, two grains the second, and two grains the third day, when diarrhoea was produced, and on the following day the animal was found dead. In a third case one grain a day, for four consecutive days, was given, then two grains and two grains again on the succeeding days. Diarrhoea was now observable, and the administration was stopped, but the rabbit died within forty-eight hours. Lastly, in another case, the quantity taken was one grain a day for three days, and then two grains a day for a similar period, when death was occasioned.

From the post-mortem appearances presented by these rabbits, it appears that the poison, in repeated doses, produces inflammation of the alimentary tract, not throughout, however, but only of certain parts of it, and the cæcum more than any other. The following is a *résumé* of the appearances observed :

Lungs congested and solidified in places.

Heart, both sides full of dark, coagulated blood.

Stomach, spots of ulceration in two cases, no decided ulceration in the other two. Patches of preternatural vascularity, and a false-membrane-like layer adherent to portions of the surface. In one case blood had evidently exuded from an ulcerated spot.

Small intestine natural throughout, with the exception of a little undue injection here and there.

Cæcum strewed with patches of ulceration; surface rough and granular, as if from the exudation of inflammatory material. In one of the rabbits the contents were plum-coloured, from the escape of blood. Signs of inflammation were also observable in the peritoneal aspect, shreds of easily detached lymph being seen.

Large intestine ulcerated, and unnaturally injected at its commencement, but natural in appearance elsewhere.

Kidneys, in each case, more or less affected in the following manner — They appeared of very large size. In one the two kidneys weighed 349 grains, and in another 326 grains. (The weight of the two kidneys of a similar sized healthy rabbit was taken for comparison, and found to be 180 grains.) The surface was highly speckled, as represented in fig. 2 of the accompanying plate. The capsule easily peeled off, leaving a hard, rough surface underneath in the more advanced specimens. In section the appearance is given at fig. 1. The medullary part presented nothing unusual in character, but the cortical part was highly striated, consisting, when examined closely, of a number of white columns imbedded in the fleshy texture of the organ, and running from the medullary part towards the surface. These white columns, reaching the surface, occasioned the speckled aspect that has been referred to. In the specimen from which the drawing has been taken, the altered structure felt quite gritty on cutting and manipulating with it. Examined microscopically, the uriniferous tubules were displayed, filled with a dark, granular matter. At fig. 3 is the appearance with an inch object-glass. As thin a section as possible was made, and the white columns are shown to consist of plugged-up tubules. The direction of the tubules in these columns is also shown. Figs. 4 and 5 give the appearance of isolated tubules under the quarter-inch power, in different stages of implication. At fig. 4 there is a natural tubule by the side of another in which the deposit has taken place in somewhat rounded masses. At fig. 5 the natural tubule is seen continuous with a portion where the deposit has occurred. In one of the two tubules the deposition is in a much greater state of advance than in the other.

The first idea that occurred on seeing the microscopic appearance was, that the deposit in the tubules consisted of an albuminous material; but in the specimen from which the plate was taken, this was proved not to be the case. The deposit is of an earthy character, and composed principally of the phosphate of lime. The Malpighian bodies seemed entirely to have escaped implication. Each one seen was perfectly free from any dark accumulation.

The urine of three of the rabbits was examined a short time before death took place. There was no albumen to be discovered in either specimen.

In addition to the experiments on the dog and the rabbit, the effects of white precipitate have been tried on the mouse. A small quantity of the poison was mixed with lard, and placed in a cage where two mice were confined. They were both found dead on the following morning.

Chemical analysis.—The following were the results of an analysis in some of these experiments:

EXPERIMENT 1.—The contents of the stomach, amounting to about 2 drachms of a brownish-coloured liquid, gave no evidence of mercury. The coats of the stomach yielded a mere trace. The contents of the small and large intestines gave no mercury, while the coats of both yielded a trace. Mercury was found in the liver and kidney, but there was none in the heart. The whole quantity separated was calculated not to exceed one eighth part of a grain. Although the quantity administered was very large (50 grains), the greater part had obviously been expelled from the body.

EXPERIMENT 2.—A rabbit was killed, in a few hours, by 5 grains. The liver and one kidney were examined. A well-marked sublimate of metallic mercury was obtained from the kidney, but none was found in the liver.

EXPERIMENT 3.—Twenty grains of white precipitate (well washed with ether) were given to a rabbit. The animal was last seen alive about seven or eight hours after it had taken the poison. No analysis was made of the contents of the stomach, but the two kidneys were found to contain a well-marked quantity of mercury.

EXPERIMENT 4.—Two grains of white precipitate were given daily to a rabbit for four days, making 8 grains altogether.

The animal was found dead. In this case mercury was found in the kidney, a mere trace was detected in the liver, and about the same quantity in the whole of the intestines and their contents. These results prove—

1st. That white precipitate, like other insoluble mineral poisons is absorbed, and its mercury is deposited in the organs. It is probably rendered soluble by the acid secretions of the stomach.

2d. That the kidneys are the chief receptacle of the poison, the liver containing a trace, and the heart none. The intestines appear to retain the poison only in small quantity.

3d. That whether the quantity administered be large or small, and whether given in one or several doses, the quantity found in the body of the animal was, in each case, very small.

Description of Plate, showing the effect of the administration of White Precipitate, in repeated doses, on the kidney of the rabbit.

Fig. 1. Section of the kidney, natural size. The highly striated appearance of the cortical part is displayed.

Fig. 2. Appearance of the surface of the kidney, showing its highly speckled character. The drawing is somewhat magnified.

Fig. 3. Microscopic appearance of a thin section of the cortical part, examined by the inch object-glass. The uriniferous tubules are seen plugged up with an earthy deposit. A collection of them into a bundle forms one of the white columns to which the striated character at fig. 1 is due.

Fig. 4. A normal tubule by the side of one in which a deposit has occurred in the form of roundish masses. These are seen by the quarter-inch glass.

Fig. 5. Likewise viewed with the quarter-inch power. Two tubules are shown with a deposit in them, to a varying degree of extent. The natural tubule is seen continuous, with a portion where the deposit has occurred.

F. W. P.

Fig 1

Fig 2

Fig 3

Fig 5.



CASE OF OVARIAN TUMOUR

CONTAINING

TEETH, HAIR, &c. ;

WITH REMARKS.

By S. JAMES A. SALTER, M.B., F.L.S., &c.

THE occurrence of tumours in the human ovary, consisting of an aggregation of structures, such as teeth, hair, bone, &c., has been so long recognised, and so frequently described, that I should not have thought it worth while to publish or comment on the present example, but for these reasons:—I have here had an opportunity of examining very critically those structures which of late I have made the objects of my especial study—*tooth structures*, and of observing how far these ovarian teeth resemble those formed in normal position and under normal circumstances. I have, in this instance, found some tissues which, I believe, have never before been recognised in such ovarian tumours; and, further, it has seemed to me that the progress of modern physiology, in reference to the question of animal generation, furnishes an explanation of the real meaning of these curious developments.

The patient from whom the specimen, now under consideration, was obtained was a married woman, aged 49, the mother of several children. She was admitted into Guy's Hospital, under the care of my late colleague, Dr. Lever, on the 1st of November, 1858. At that time she was not actually ill, but felt, and had for some weeks felt, pains and uneasy sensations

in the pelvis ; and suspecting that there must be something the matter with her womb, she sought professional assistance at the hospital.

Upon making a *per-vaginam* examination, a tumour was felt on the right side of the uterus, and, as far as could be judged, was about the size of an orange. No urgent symptoms required interference, and the patient was kept in the hospital several days, rather under observation than under treatment. After she had been in the hospital about a week or ten days, she was suddenly seized in the night with symptoms of acute peritonitis, and in a few hours she expired.

On post-mortem inspection the body had the appearance of a woman who had died of acute disease ; the organs generally presented an aspect of health and good nourishment ; and, barring the recent results of acute peritonitis, they were all natural except the right ovary.

The peritoneal cavity exhibited abundant evidence of recent acute inflammation, sufficient to account for death ; and this was caused by the extravasation of a small portion of the contents of a cystic tumour, into which the right ovary had been converted, and which had burst by a very small aperture. This tumour was about the size of a closed fist or an orange, and it lay in the pelvis, on the right side of the uterus ; it was adherent by lymph to the parts around ; it had not collapsed, was not empty, but, when detached, some of the fluid contents oozed from it through the existing opening. It was found to be a large cyst developed in the right ovary. The uterus and left ovary were healthy and natural in all respects. Upon opening the cyst, a quantity of serous fluid escaped ; it appeared to be composed of serum and fatty matter, and within were found large white masses of fat and bundles of hair. Upon removing the loose contents of the tumour, the interior was seen to be lined with a soft, pink, serous-like membrane ; on the anterior surface, the crowns of three teeth projected free, and beneath them could be felt a mass of bone ; close to this was a projection of a brown colour, about the size of a broad-bean, from the surface of which sprouted some fine, pale, brown hair. The hair found loose in the cyst had no doubt been shed. The free masses of fatty matter were structureless, and wholly dissolved in ether without any residue. The

roundness of these pellets of fat, and the matting of the hair, would make it seem probable that some rotatory motion had existed within the cyst during life, or had been communicated to it by neighbouring organs.

Of the three teeth, the two largest were implanted in the subjacent bone by means of true fangs; the smaller one was simply adherent to the lining membrane, and had no fang—a condition not unfrequently seen in congenital teeth—teeth, that is, which are already in the mouth at birth.

All the tissues were submitted to careful microscopical scrutiny.

The lining membrane of the cyst, throughout its chief extent, resembled fibro-serous membrane, being covered by a layer of thin, soft, pale epithelium, the epithelial cells being small, somewhat lozenge-shaped, and having an oval nucleus. I could not, in this portion of the lining, discover any basement membrane or papillæ. Beneath the epithelium a sheet of white, fibrous tissue was found, but no yellow. Portions of the tissue, upon the addition of acetic acid, displayed very characteristic, club-shaped nuclei—those of unstriped muscle; but whether these belonged to the walls of blood-vessels, or to dermal muscle-cells, I cannot say. The action of acetic acid also developed countless multitudes of minute cells, nucleus-like, about the $\frac{1}{3000}$ th of an inch in diameter.

The teeth resembled a *dens sapientiæ* and two premolars, one of the latter being destitute of fang. The two larger teeth contained pulps; in the smaller the pulp cavity was completely obliterated—the dentinal tubes radiating from a central point, not a cavity. Under the microscope, sections, both vertical and transverse, of all three tissues, enamel, dentine, and crusta-petrosa, presented every normal appearance, and it would be utterly impossible, from structural examination, to discover any difference between these and ordinary human teeth. In the plates accompanying this paper, the teeth will be seen, *in situ*, in Plate I, and as they appeared when removed from the jaw, in Plate II, figs. I, 2, and 3. The larger tooth, in this plate, is a little too much curved in the fang; but, excepting this, the illustrations are very exact. Figure 4, of the same plate, displays the general arrangement of the three tissues of the teeth, as seen by a vertical section

of the larger tooth. The enamel is abundant, and has that irregular disposition which one so often sees in an upper wisdom-tooth; the radiation of the dentinal tubes, from pulp-cavity to surface, is quite natural; the clothing of the fang with crusta-petrosa is rather thin, and, from the irregular form of the dentinal axis of the end of the fang, a vertical section has brought the cement into view, in patches somewhat; there is, however, nothing uncommon in this. But the most interesting result of this investigation was the discovery of nerves in the tooth-pulp; nerves having, as yet, I believe, never been recognised in any of these ovarian tumours. I am aware that a mass of brain has been found in an ovarian cyst, by Mr. Henry Grey, in a case to be referred to presently, but nerves normally distributed among other tissues have never yet been described. The pulps of both the larger teeth were submitted to microscopical scrutiny, and no one could have detected the slightest difference between them and those of ordinary teeth; the same cell-elements were present, the same vascular plexuses, and the same bundles of nerves in equal numbers. The action of dilute *liquor sodæ* displayed the outline of the nerves with the usual sharpness: there was the same long, plexiform disposition of the nerve-fibres; large bundles in the axis, smaller ones towards the surface; and the fibres themselves exhibited the usual aspect, and were of the normal diameter.¹

The bone, in which the teeth were implanted, was covered everywhere by periosteum, which also lined the cavities in which the fangs of the teeth were lodged. The bone itself consisted entirely of cancellated tissue, without any compact limitary outline to indicate the form of any recognisable bone. As two of the teeth were held in genuine alveoli, the bone was, no doubt, *maxilla*, either upper or lower.

The bone, examined by the microscope, exhibited multitudes of true lacunæ, not to be distinguished from those of ordinary human bone; some resembled those found in rickety bone,

¹ It is worthy of note that the pulps of these teeth had not undergone any intrinsic calcification,—there were no *calcification islands* in their substance whatever, the pulps themselves never having been the subjects of inflammation, nor the crowns of the teeth exposed to those sources of lesion (caries, friction wear, &c.) which are the common causes of intrinsic calcification of the pulps.

as described by Kölliker, that is, the lacunæ were axial to large development-cells. Attached to one part of the bone I found some large fibres, tolerably even in size, and which I can only imagine to have been immature muscle, not yet sufficiently differentiated to show the transverse striæ; these fibres had no sarcolemma. The mass was of a pinkish colour; but I will not say positively that it was muscle, though I think it was.

The projection covered with hair, which I have already referred to, resembled a common piece of hairy integument, the hair being very fine and soft, like that of a foetal scalp. Upon submitting to the microscope sections of this structure, made vertical to the surface, they displayed all the elements that enter into the formation of the scalp; cuticle upon the surface covering in papillæ, numerous hairs clothed in sheaths, and abundant large, well-formed sebaceous follicles, opening into the hair-tubes; among the roots of the hairs, and beneath them, were numerous little agglomerations of subcutaneous adipose tissue. Figure 5, in Plate II, is rather a diagrammatic representation of the appearances presented. The foetal character of the hair was very unmistakable, constituting true *lanugo*: upon careful and repeated scrutiny, I could find no medulla in any of these hairs, they being wholly composed of a fibrous axis and cuticle.

It is unnecessary to enter into further histological details: it is sufficient to have enumerated all the elementary tissues I discovered in this tumour—tissues which, be it remembered, were found all normal in themselves, though abnormally situated. The tissues in this specimen were as numerous as in any single ovarian tumour of the kind, of which we have any published account; but other structures have been found by other anatomists, which I did not here recognise. Thus, Kohlrausch and Heschl found sweat-ducts, arranged like those of the human skin, and which very likely existed, though I did not detect them, in the specimen I examined, as all the other skin-structures were so singularly perfect; but the most remarkable histological discovery connected with this subject was made some years since by Mr. Henry Gray, in the dead-house of St. George's Hospital, when, in one of these so-called "ovarian tumours," he found a considerable nervous centre—a brain or a ganglion. The patient was a *single* young

woman, who died of typhus fever: the growth in the ovary contained hair, teeth, &c., as well as nervous matter; it was never suspected, and it had given rise to no symptoms during life. In describing the structure of the brain-mass, Mr. Gray remarks: "On microscopic examination, it was found to consist entirely of the ordinary elements of nervous matter, being composed of a very large number of varicose nerve-tubules of varying size, intermixed with the elementary components of grey matter, viz., nuclei and nucleated vesicles containing granules."¹ This description is accompanied by an illustration, which very characteristically depicts grey matter of the brain. Mr. Gray concludes his paper with these words: "As far as I have been able to ascertain, nervous matter has never been previously found as forming a part of the contents of these cysts. It is from this circumstance that I have deemed it right to bring this case before the notice of the Society, as it may assist, to a certain extent, at some future period, in explaining the law which governs the development of these remarkable tumours." And truly Mr. Gray's new fact is a very important and a very significant addition to our knowledge of this matter.

Let me now enumerate the different structures that have been found, from time to time, by different anatomists, in these ovarian developments. Mr. Gray has found a *nervous centre*; I have found *distributed nerves*; *besides these blood-vessels, bone, periosteum, dentine, crusta-petrosa, enamel, tooth-pulp, unstriated muscle, striped muscle (?)*, *areolar tissue, adipose tissue, epithelium, epidermis, sweat-ducts, sebaceous follicles, fœtal hair*, have all been recognised in these growths.

Such an aggregation of structures, adventitious to the individual in whom they are found, and situated in the essential generative organ of the female, can have but one meaning: they represent a fresh individual of a succeeding generation, though the anatomical *form* of that individual is not normal, and the life of the new mass is still dependent on the parent. Here come the questions—What calls forth these curious developments? Are they the result of conception, as it occurs normally in the human subject? The latter question first.

¹ An Account of a Dissection of an Ovarian Cyst which contained Brain, by Henry Gray, F.R.S., 'Med.-Chir. Trans.,' vol. xxxvi; 1853.

All evidence, both negative and positive, that we have bearing on this point, militates against the idea that these developments are ever produced by the action of the two sexes ; in many instances we have positive evidence that they cannot have been thus produced. In the example of such a development occurring in the ovary of a female who had had sexual intercourse (as in the instance I have here described), the circumstance *may* be interpreted as an aborted result of a normal impregnation—a true gamo-genesis—the impregnated ovum, however, failing to reach the proper organ for its maturation, the uterus, and thus, imperfectly nourished, failing to yield its proper issue. But upon this doubtful point, all the evidence we have (it *is* and only *can* be *negative*) leads to the opposite conclusion ; because we know (there are many instances on record) that extra-uterine gestation may occur, without in any way blighting or interfering with the development of all the parts of the ovum, including the foetus ; whereas we have no evidence of the reverse—we have no evidence that an ovum properly impregnated by spermatic action, and by accident failing to detach itself from the ovary, would become converted into an amorphous tumour, bearing foetal tissues. To say that such growths occurring in married women are thus produced, is a simple assumption. However, the point does not rest here ; it does not rest upon the question of doubtful spermatic impregnation, or upon negative evidence. These growths are found in the ovaries of virgins. Many such cases are on record ; and I myself once made a post-mortem examination of the body of a young lady, of whose maiden purity and of whose physical virginity there could be no doubt. In one of her ovaries were found teeth and hair. But if a disputant should question the evidence of chastity, and the proofs of virginity, there is this other fact, which puts the matter beyond all cavil : these developments occur in girls before puberty—before the female organs are susceptible of spermatic stimulation, and when, as yet, gamo-genesis is a physiological impossibility. Such cases are not numerous, but they do occur ; and one of the most striking, and one entirely reliable, came under the cognizance of Rokitansky, in a little girl *six years of age*. The parts are now in the Imperial Pathological Museum at Vienna.

So much for this point: the other—the question as to what calls forth these ovarian developments—appears to me to receive its answer, rather than explanation, in analogy; in the analogy which these formations have to the non-sexual reproduction which is now known to prevail in many of the lower animals.

It is now more than a century ago that Bonnet¹ first established the fact that certain insects, Plant-lice, or *Aphides*, may multiply without sexual intercourse, and that this may be repeated for many generations without copulation. This was the first break upon the doctrine universally held before, that animal life could alone be propagated by the conjugation of sexes; but since then, instances of independent female fertility have become so well established, and so numerous, that the whole aspect of the physiology of reproduction has been changed. It is not my purpose here to dwell at any length on this now well-established fact, the existence in some animals of the power of a-sexual proliferation (*agamo-genesis*), as well as the process by union of the two sexes (*gamo-genesis*), which more conspicuous, and probably more general method has always been known to physiologists. I may mention, however, two striking examples. The *Daphnia*, a small entomostracous crustacean, has long been known to produce young, for several generations of females, without the action of the male. At first the fertile virgin females were thought to be hermaphrodite, but such is not the case: the sexes are in single individuals, and series of prolific females have been traced through four and even more generations, when altogether separated from males, and when spermatic influence was impossible. Another instance—that of the hive bees—is very singular and striking. It has been shown by Von Siebold, that the eggs of the parent (queen) bee become female or male, according to whether they have or have not received the spermatic influence of the male parent: thus all the eggs which have been subjected to sexual action become either queen or workers—essentially female, while the unimpregnated eggs yield males—the non-workers, or drones; so that the eggs which have not received spermatic influence still produce living young.

¹ *Traité d'Insectologie*, 1745.

I do not dwell further on examples of the a-sexual reproduction of the lower animals. The medical reader, whose attention has perhaps been too much confined to the narrower, but more practical, field of study—human pathology—to be fully aware of the changed views which very modern research on the subject of generation has forced on the physiologist, would do well to read Professor Huxley's admirable memoir on the "Agamic Reproduction of *Aphis*," in the 'Transactions of the Linnean Society.'¹ Professor Huxley's paper, while it gives critical details of the a-sexual reproduction of one animal, *Aphis*, contains the most complete *résumé* of the whole subject of *agamo-genesis* (generation in a *single* individual), or *parthenogenesis* (virgin generation), which scientific literature at present furnishes. I will only quote one passage from Professor Huxley's memoir:—"Time was when the difficulty of the physiologist lay in understanding reproduction without the sexual process. At the present day it seems to me that the problem is reversed, and that the question before us is—Why is sexual union necessary?"

It will, perhaps, ultimately turn out that the faculty of agamo-genesis is latent in all animal life; and that, whereas in many of the lower forms (scattered irregularly through the invertebrata) it is the occasional or prevailing method for reproducing the kind, in the higher forms it is inefficient for that purpose, and is only exceptionally manifested as a physiological phenomenon. But however widely, or otherwise, this observation may apply, it seems to me that these ovarian developments in the human ovary are a manifestation of the phenomenon in question; that they are not analogous in any sense to other adventitious growths which the pathological anatomist meets with, but that they are altogether equivalent to *virgin-produced* "*zooids*" previous to their detachment from the parent.

¹ 'On the Agamic Reproduction and Morphology of *Aphis*,' by T. H. Huxley, F.R.S., &c., 'Trans. Linn. Soc.,' vol. xxii.

PLATE I

*Illustrates Mr. Salter's specimen of Ovarian Tumour,
containing teeth, &c.*

The uterus is exhibited on the posterior surface, slit up vertically. The ovarian cyst, also opened posteriorly, displays the crowns of three teeth implanted in bone: further to the right is a mass of scalp-like structure, from the surface of which small lanuginous hairs are sprouting.

PLATE II.

Fig. 1. Ovarian tooth, resembling *dens sapientiæ*.

Figs. 2 and 3. Ovarian teeth, resembling premolars; fig. 3 being without fang.

Fig. 4. Vertical section of tooth represented in fig. 1, slightly magnified.

Fig. 5. Section of scalp-like structure, slightly magnified, exhibiting hairs, sebaceous follicles, and adipose tissue.

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LIST
OF
GENTLEMEN EDUCATED AT GUY'S HOSPITAL
WHO HAVE PASSED THE
EXAMINATIONS OF THE SEVERAL UNIVERSITIES, COLLEGES,
&c. &c.

*Also those who have obtained the several appointments at Guy's, since
September, 1859.*

University of London.

SECOND EXAMINATION FOR BACHELOR OF MEDICINE.

* Mr. Walter Moxon . First Division.

* Obtained Honours in Comparative Anatomy, Medicine, Surgery, and
Midwifery.

FIRST EXAMINATION FOR BACHELOR OF MEDICINE.

Mr. Frederick Meggy. }
* Mr. J. T. Mercer. } First Division.

* Obtained Honours in Anatomy.

MATRICULATION EXAMINATION.

Mr. Edwin Moore. — T. O. Duke. * John Tanner		* Mr. Rowe. Mr. Francis Trimmer.
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* Obtained Honours in Zoology.

University of St. Andrew's.

Dr. Thomas Kitchener. — John Cook. — Edward Appelbee. — Egbert Charlton.		Dr. Edmund Heginbotham. — John M'Keever. — John Cheeseman.
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522 Gentlemen admitted to Practice since September 1859.

Unibersity and King's College, Aberdeen.

Dr. T. H. Waterworth. | Dr. John Candy.

Licentiates of the Royal College of Physicians of Edinburgh.

Dr. James Palfrey. | Dr. John Wilton.

Royal College of Surgeons of England.

FELLOWS BY EXAMINATION.

Mr. Arthur E. Durham. | Mr. W. H. Aldersey.

MEMBERS BY EXAMINATION.

OCTOBER.

Mr. Robert Barlow.

DECEMBER.

Mr. Thomas Kitchener.	Mr. W. J. Addison.
— David Bowen.	— Henry Horsley.
— G. H. Atwell.	— Thomas Miller.
— J. Garside Terry.	— W. C. N. Murphy.

JANUARY.

Mr. John Candy.

FEBRUARY.

Mr. C. Gayleard.	Mr J. L. King.
	Mr. John Wilton.

APRIL.

Mr. Frank Buszard.	Mr. H. B. Trimmer.
— Edward Fernie.	— H. R. S. Ridsdale.
— James Duce.	— H. W. Lomas.
— Edward Appelbee.	— William Park.
— John Woodman.	— Isaac Morris.
— Edwin Lloyd.	— Hugh Bennett.
— A. L. Haynes.	— John Hostetter.

MAY.

Mr. W. T. D. Caldwell.	Mr. F. M. Cann.
— Richard Davy.	— Walter Watkins.
— George Charles Walker.	

Gentlemen admitted to Practice since September 1859. 523

JULY.

Mr. J. F. Lovegrove.

Mr. A. Harvey Smith. | Mr. E. W. Coleman.

AUGUST.

Mr. C. Hilton Fagge.
— E. B. Truman.
— R. H. Smith.

Mr. Henry Trimmer.
— W. M. G. Maclure.

FIRST, OR ANATOMICAL AND PHYSIOLOGICAL EXAMINATION.

NOVEMBER, 1859.

Mr. Cuthbert Johnson.
— R. H. Smith.

Mr. Christopher Gayleard.
— John Lyons King.

JANUARY, 1860.

Mr. Henry Trimmer.
— Francis Trimmer.

Mr. H. R. S. Ridsdale.
— G. D. Harding.

MARCH AND APRIL.

Mr. T. W. King.
— F. Meggy.
— H. M. Hawkins.
— T. H. Rowe.
— John Tanner.

Mr. W. L. Cass.
— Morgan J. Edwards.
— J. F. Stamper.
— C. Ballard.
— Sidney Thorpe.

APRIL.

Mr. Walter Mackern.
— Edward Green.
— W. F. Smith.

Mr. Thomas Holmestead.
— J. E. Davey.

APRIL AND MAY.

Mr. John Dollman.
— H. A. Martin.
— C. H. Greaves.
— J. Lloyd Jones.
— Owen Owen.
— Arthur Roper.
— G. Griffiths.
— Wm. Mortimer.
— Wm. Soper.

Mr. John Makens.
— G. C. Douglas.
— P. R. J. B. Minns.
— Belgrave Ninnis.
— Samuel Maughan.
— I. H. Swain.
— Edward Leeds.
— Washington Lovegrove.
— C. J. Pocock.

MAY.

Mr. A. H. Smith.

Mr. Lionel Burrell.

524 *Gentlemen admitted to Practice since September, 1859.*

JULY.

Mr. J. A. Ferris.

Licentiates in Midwifery.

Mr. E. S. Blaker.
— W. T. Salmon.
— J. Woodman.
— G. H. Atnell.

Mr. Egbert Charlton.
— C. Lovegrove.
— J. Wilton.

Licentiates of the Apothecaries' Society.

SEPTEMBER, 1859.

Mr. J. Arminson.
— N. Greenwood.

Mr. Thomas Joyce.
— H. Horsley.

OCTOBER.

Mr. A. E. Barrett.

Mr. John Jones.
Mr. Joseph May.

NOVEMBER.

Mr. J. Bankart.

DECEMBER.

Mr. Stephen Duke.

Mr. J. T. F. Firth.

FEBRUARY, 1860.

Mr. Edward Fernie.
— Edward Stilwell.

Mr. J. S. Tuke.
— J. Woodman.

MARCH.

Mr. Roger Nunn.

Mr. W. Watkins.

MAY.

Mr. John James Beer.

Mr. J. Garside Terry.

JUNE.

Mr. Robert Tanner.

Mr. W. E. G. Barnes.

JULY.

Mr. Isaac Morris.
— Wm. Park.
— L. Burrell.

Mr. E. B. Truman.
— J. N. Earle.

AUGUST.

Mr. A. L. Haynes.

FIRST EXAMINATION.

JUNE.

Mr. J. B. Bromley.

JULY.

Mr. Isaac Morris.

AUGUST.

Mr. W. T. D. Caldwell.

SEPTEMBER.

Mr. W. C. Wise.

DECEMBER.

Mr. R. Tanner.

Mr. H. W. Lomas.

APRIL.

Mr. Francis Trimmer.

Mr. J. Makens.

JULY.

Mr. F. Meggy.

AUGUST.

Mr. C. J. Pocock.
— John Tanner.
— Sidney Thorp.
— Thomas Holmestead.
— T. H. Passmore.

Mr. Wm. Soper.
— C. Ballard.
— J. E. Davey.
— Edward Green.
— Arthur Roper.

526 *Gentlemen who have held the appointment of Dressers.*

**LIST OF GENTLEMEN WHO OBTAINED MEDALS AND PRIZES AT THE
HOSPITAL EXAMINATIONS IN SESSION 1859-60.**

THIRD YEAR'S STUDENTS.

E. Becket Truman, Nottingham, first Prize, £40.
F. Mark Cann, Exeter, second Prize, £35.
E. Becket Truman, the Treasurer's Gold Medal for Clinical Medicine.
F. Mark Cann, the Treasurer's Gold Medal for Clinical Surgery.

SECOND YEAR'S STUDENTS.

Thomas Holmestead, Braintree, Essex, first Prize, £35.
James F. Stamper, Haverfordwest, second Prize, £30.
P. R. J. B. Minns, Nassau, N.P., Bahama, third Honorary Certificate.
John Makens, Bildeston, fourth Honorary Certificate.

FIRST YEAR'S STUDENTS.

Thomas Stevenson, Rainton, Yorkshire, first Prize, £30.
J. St. T. Clarke, Leicester, second Prize, £25.
John H. Evans, Brynguran, Holyhead; Peter Procter, Thorne, Yorkshire; W. R. Grove, Wrentham, Suffolk; Joseph Willes, Brighton; William Murdoch, Rotherhithe; Henry Hicks, Camberwell; Joseph Lamb, Warrington, Lancashire; J. A. Taylor, West Bromwich; Robert Slade, Bermondsey; F. Woodman; T. D. Welch, Tottenham; A. G. Wilks, Nursling, Southampton; Candidates to whom Honorary Certificates were awarded (in order of merit).

**ENTRANCE EXAMINATION IN CLASSICS, MATHEMATICS, &c.
OCTOBER, 1859.**

First and second Prizes, W. Murdoch, T. D. Welch, equal, £22 10s.
Third Prize, A. G. Wilks, £15.
J. St. T. Clarke, T. Stevenson, Joseph Willes, F. Woodman, Candidates to whom Honorary Certificates were awarded (in alphabetical order).

**GENTLEMEN WHO HAVE HELD THE APPOINTMENT OF
HOUSE-SURGEON.**

Mr. James Baukart.

| Mr. Egbert Charlton.

GENTLEMEN APPOINTED DRESSERS SINCE OCTOBER, 1859.

Mr. Frank Buszard.

— John Woodman.
— Joseph May.
— H. R. S. Ridsdale.
— G. D. Harding.
— Hugh Bennett.
— E. W. Coleman.
— William Park.
— F. M. Cann.
— E. B. Truman.
— A. L. Haynes.
— Richard Davy.

Mr. Charles Hilton Fagge.

— J. F. Lovegrove.
— James Beddard.
— J. H. Galton.
— J. S. Tuke.
— W. C. Wise.
— J. Symons.
— Washington Lovegrove.
— C. H. Greaves.
— H. A. Martin.
— J. T. Mercer.
— Edward Appelbee.

DRESSERS TO THE ASSISTANT-SURGEONS.

Mr. W. C. Wise.	Mr. Washington Lovegrove.
— Edwin Lloyd.	— T. D. Caldwell.
— W. Soper.	— Pembroke R. Minns.
— J. F. Stamper.	— Herbert Topham.
— Thomas Holmestead.	— John Makens.
— J. E. Davey.	— J. Edwards.
— W. Watkins.	— W. A. Watson.
— J. B. Bromley.	— John Tanner.
— C. H. Greaves.	— Owen Owens.
— Frederick Meggy.	— Sidney Thorpe.
— C. Ballard.	— W. Mortimer.
— E. Green.	— G. Griffiths.
— W. L. Cass	— T. H. Rowe.
— S. H. Macpherson.	— Richard Davy.
— Walter Mackern.	— C. H. Fagge.
— R. C. Titt.	— A. Gardiner Brown.

DRESSERS IN THE OPHTHALMIC WARDS.

Mr. H. Bennett.	Mr. G. A. Major.
— W. Park.	— F. Buszard.
— J. B. M. Evans.	— W. Caldwell.
— W. C. Wise.	— P. R. J. B. Minns.
— Edwin Lloyd.	— Thomas Holmestead.
— J. Morris.	— J. F. Stamper.

GENTLEMEN APPOINTED CLINICAL CLERKS.

WINTER SESSION, 1859-60.

Mr. Cuthbert Johnson.	Mr. F. M. Cann.
— Richard Davy.	— Egbert Charlton.
— J. H. Galton.	— James Beddard.
— A. W. A. Evans.	— G. H. Atwell.
— C. H. Fagge.	— F. P. Weaver.

SUMMER SESSION, 1860.

Mr. Frederick Meggy.	Mr. Isaac Morris.
— J. F. Stamper.	— W. H. Lomas.
— T. Holmestead.	

**GENTLEMEN APPOINTED TO CONDUCT THE POST-MORTEM
EXAMINATIONS.**

Mr. Edwin Lloyd.	Mr. F. M. Owen.
— W. Watkins.	— E. Moore.
— F. Buszard.	— G. A. Major.
— Isaac Morris.	— Owen Owens.
— T. D. Caldwell.	— John Tanner.
— J. Symons.	— P. R. J. B. Minns.

SENIOR RESIDENT OBSTETRIC CLERKS.

1859. September . . .	{ Mr. M. Adams.
October . . .	— Bransby Brooks.
November . . .	— G. H. Atwell.
December . . .	— Egbert Charlton.
1860. January . . .	— J. S. Tuke.
February . . .	— T. Miller.
March . . .	— J. F. Lovegrove.
April and May . . .	— John Woodman.
June . . .	— W. Watkins.
July . . .	— H. W. Lomas.
August . . .	— E. B. Truman.
September . . .	— Richard Davy.
	— Belgrave Ninnis.

HONORARY OBSTETRIC CERTIFICATES.

Awarded since October, 1859, for attending above 100 cases of labour
during twelve months.

Mr. J. B. M. Evans.	Mr. A. Freeman.
— G. P. Sargent.	— R. Slade.

PUPILS' PHYSICAL SOCIETY'S PRIZE.

Awarded to Mr. E. B. Truman.

GUY'S HOSPITAL.

1860-61.

THE MEDICAL SESSION.

COMMENCES ON THE FIRST OF OCTOBER.

The Introductory Address will be given by Dr. WILKS, on Monday, the First of October, at Two o'clock.

Gentlemen desirous of becoming Students must produce satisfactory testimony as to their Education and Conduct; they are required to pay £40 for the first year, £40 for the second year, and £10 for every succeeding year of attendance. One payment of £100 entitles a Student to a perpetual Ticket.

The payment for the year admits to the Lectures, Practice, and all the Privileges of a Student for that year only.

Clinical-Clerks, Dressers, Ward-Clerks, Dressers'-Reporters, Obstetric-Residents, and Dressers in the Eye-Wards, are selected according to merit from those Students who have attended a second year. Each Dresser (except those in the Eye-Wards) has the privilege of rooms and commons in the Hospital free of charge for one month of his course. The Obstetric Residents have the like privilege for two months each—one month as junior, another as senior. A Resident House-Surgeon is appointed every six months from those Students who have obtained the College Diploma.

Every Student is required to conform to the Rules and Regulations for the internal management of the Hospital.

The privileges of a Student will be withdrawn in the event of neglect or misconduct.

Certificates will not be given for Lectures or Practice, unless duly attended.

The Winter Session terminates March 31st.

The Summer Session commences May 1st, and concludes July 30th.

MEDICAL OFFICERS.

Physicians.—G. H. BARLOW, M.D.; OWEN REES, M.D., F.R.S.; W. W. GULL, M.D.

Assistant-Physicians.—S. O. HABERSHON, M.D.; S. WILKS, M.D.; F. W. PAVY, M.D.

Surgeons.—EDWARD COCK, Esq.; J. HILTON, Esq., F.R.S.; J. BIRKETT, Esq.

Assistant-Surgeons.—ALFRED POLAND, Esq.; COOPER FORSTER, Esq.; T. Bryant, Esq.

Obstetric Physician.—HENRY OLDHAM, M.D.

Assistant Obstetric Physician.—J. BRAXTON HICKS, M.D.
Surgeon-Dentists.—T. BELL, Esq., F.R.S., and PRES. L.S.;
 J. SALTER, Esq.
Surgeon of the Eye Infirmary.—JOHN F. FRANCE, Esq.
Apothecary.—JAMES STOCKER, Esq.

LECTURES, &c. WINTER COURSES.

Medicine.—DR. OWEN REES and DR. GULL, Mondays, Wednesdays, and Fridays, at half-past three.

Clinical Medicine.—DR. BARLOW, DR. OWEN REES, and DR. GULL.

Surgery.—MR. HILTON and MR. BIRKETT, Tuesdays, Thursdays, and Saturdays.

Clinical Surgery.—MR. COCK, MR. HILTON, and MR. BIRKETT.

Anatomy, Descriptive and Surgical.—MR. POLAND and MR. COOPER FORSTER, Mondays, Tuesdays, Thursdays, Fridays, and Saturdays, at nine.

Physiology and Microscopic Anatomy.—DR. PAVY, Tuesdays, Thursdays, and Saturdays, at a quarter past twelve.

Demonstrations on Anatomy.—MR. DURHAM and MR. MOXON, daily.

Demonstrations on Morbid Anatomy.—DR. WILKS, daily, at half-past two.

Clinical Lectures on Midwifery and Diseases of Women.—DR. OLDHAM.

Chemistry.—DR. ALFRED S. TAYLOR, Tuesdays, Thursdays, and Saturdays, at eleven.

Experimental Philosophy.—MR. DURHAM, Wednesdays, at twelve.

Pupils' Physical Society.—Saturdays, alternate, at seven in the evening.

The Clinical Wards will open the first week in October.

Lying-in Charity.—DR. OLDHAM and DR. J. BRAXTON HICKS.

Curator of the Museum.—DR. WILKS.

SUMMER COURSES.

Demonstrations on Cutaneous Diseases.—DR. GULL, Mondays, at half-past one.

Materia Medica.—DR. HABERSHON, Tuesdays, Thursdays, and Saturdays, at three.

Clinical Medicine.—DR. HABERSHON, DR. WILKS, and DR. PAVY.

Clinical Surgery.—MR. POLAND, MR. COOPER FORSTER, and MR. BRYANT.

Midwifery.—DR. OLDHAM, Tuesdays, Wednesdays, Thursdays, Fridays, and Saturdays, at a quarter to nine.

Medical Jurisprudence.—DR. ALFRED S. TAYLOR, Tuesdays, Thursdays, and Saturdays, at ten.

Ophthalmic Surgery.—MR. FRANCE, Wednesdays and Fridays, at three.

Pathology.—DR. WILKS, Mondays, at twelve.

Dental Surgery.—MR. SALTER.

Comparative Anatomy and Zoology.—DR. PAVY, Tuesdays and Thursdays, at half-past twelve.

Botany.—MR. JOHNSON, Tuesdays, Thursdays, and Saturdays, at half-past eleven.

Practical Chemistry.—DR. ODLING, Mondays, Wednesdays, and Fridays, ten to one.

Operative and Manipulative Surgery.—MR. BRYANT, Mondays, at three.

The Clinical Wards will open the first week in May.

Registrars.—*Medical*—MR. MOXON; *Surgical*—MR. BRYANT.

MR. DURHAM and MR. MOXON will assist Pupils in their Studies.

THE LIBRARY, MUSEUMS, AND MODEL-ROOMS, ARE OPEN DAILY TO THE STUDENTS, FROM NINE O'CLOCK A.M. TILL FIVE O'CLOCK P.M.

MR. STOCKER, *Apothecary to Guy's Hospital*, is authorised to enter the Names of Students.

VOLUNTARY EXAMINATIONS

WILL BE HELD AT FOUR PERIODS OF THE STUDENT'S COURSE,
AS FOLLOWS:

FIRST.—At Entrance; and will take place on Monday, October 15th. It will comprise Elementary Classics, Ancient and Modern History, and Mathematics. The Candidate who shall distinguish himself the most, will receive £25; the second Candidate, £20; and the third, £15.

SECOND.—At the end of July in the first year, on all the Subjects of the first year's Course of Study, one sum of £30, and another of £25, will be given according to proficiency.

THIRD.—At the end of July in the second year, on the subjects which form the Course of Study up to that time, £35 and £30.

FOURTH.—At the end of July of the third year, on all the Subjects of the Curriculum, £40 and £35.

No Prize will be awarded unless the Candidates possess sufficient merit.

HONORARY CERTIFICATES will be given to those Candidates who pass a creditable Examination.

SPECIAL EXAMINATION.

TWO GOLD MEDALS will be given annually by the Treasurer to Students at the end of their third year: one for Clinical Medicine, and the other for Clinical Surgery.

ASTLEY COOPER PRIZE.

The Seventh Triennial Prize of Three Hundred Pounds,

Under the Will of the late SIR ASTLEY COOPER, Bart.,

WILL BE AWARDED TO

THE AUTHOR OF THE BEST ESSAY OR TREATISE

**“ON THE ANATOMY, PHYSIOLOGY, AND
PATHOLOGY OF THE HUMAN PANCREAS.”**

THE Condition annexed by the Testator is, “That the Essays or
“Treatises written for such Prize shall contain original experiments
“and observations, which shall not have been previously published;
“and that such Essays or Treatises shall (as far as the subject shall
“admit of) be illustrated by preparations and drawings, which pre-
“parations and drawings shall be added to the Museum of Guy’s
“Hospital, and shall, together with the Work itself and the sole and
“exclusive interest therein and the copyright thereof, become thence-
“forth the property of the Hospital, and be transferred as such by
“the successful candidate.”

It is the will of the Founder that no Physician, or Surgeon, or
other officer for the time being, of Guy’s Hospital or of St. Thomas’s
Hospital, nor any person related by blood or affinity to any such
Physician, or Surgeon, or other officer for the time being, shall at any
time be entitled to claim the Prize; but, with the exception here
referred to, this (the Astley Cooper) Prize is open for competition to
the whole world.

Candidates are informed that their Essays, either written in the
English language, or, if in a Foreign Language, accompanied by an
English translation, must be sent to Guy’s Hospital on or before
January 1st, 1862, addressed to the Physicians and Surgeons of Guy’s
Hospital.

Each Essay or Treatise must be distinguished by a Motto, and be
accompanied by a sealed envelope containing the Name and Address
of the Writer. None of the envelopes will be opened, except that
which accompanies the successful Treatise. The unsuccessful Essays
or Treatises, with the illustrative preparations and drawings, will
remain at the Museum of Guy’s Hospital until claimed by the respec-
tive writers or their agents.

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